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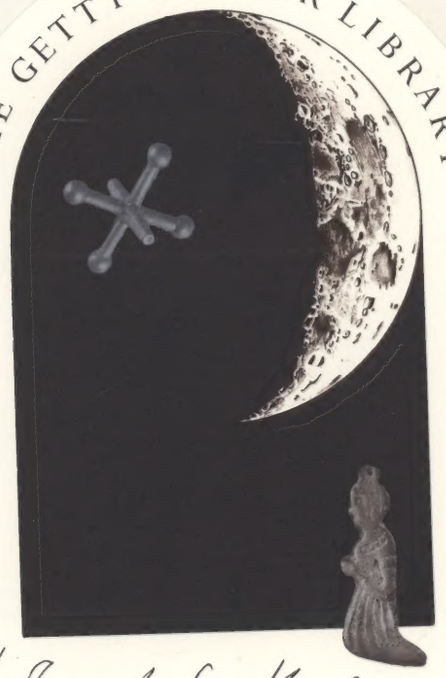

Why ask for the moon
when we have the stars?

AS

The San Francisco Earthquake and Fire

A BRIEF HISTORY OF THE DISASTER

A Presentation of Facts and Resulting Phenomena, with Special Reference to the Efficiency of Building Materials Lessons of the Disaster

By

A. L. A. HIMMELWRIGHT, C.E.

M. AM. SOC. C. E., Etc.

THE ROEBLING CONSTRUCTION COMPANY

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$5.00

COMMUNICATION

To the Board of Directors,

The Roebling Construction Co.,

Trenton, N. J.

GENTLEMEN: In accordance with your wishes, as soon as the conditions were favorable and it was possible to visit the burned district, I made a special trip to San Francisco and made a detailed inspection and examination of the fire-proof buildings. Nearly three weeks were devoted to this work. During this time I visited and personally examined every building of fire-proof construction within the burned district. This examination was as complete as it was possible to make it at the time, and consisted of a careful and systematic study of each building. The exterior was minutely scrutinized, after which each story was examined from top to bottom. In the case of the large buildings, all the halls in each story were perambulated and copious notes made on the spot of any fact that was of special interest.

In order to get accurate results, a special convertible architect's level was used to level the foundations and plumb the walls of the most important buildings.

The physical difficulties of this work were many. The stairways and other means of access to the stories of the different buildings were often destroyed. It was necessary in many cases to overcome the restrictions of the authorities and owners to prevent persons from entering and examining the buildings, some of which were in an unsafe condition. There were also a number of lesser earthquake shocks that occurred while this work was being performed, which precipitated the loose *débris* and added an element of danger. The work was, nevertheless, extremely interesting, and was prosecuted with great vigor, sixteen to eighteen hours per day being devoted to it.

In the accompanying report I have made an earnest effort to present facts only. No pains were spared in order to secure absolute accuracy. Nothing was taken for granted. Only statements of responsible persons who were in a position to know the facts were accepted. At every hand there was a tendency to ascribe wrecks and failures to dynamiting. Such claims were in all cases carefully investigated, and eliminated where they were unfounded. This report in all its details can, therefore, be accepted as correct.

The successful manner in which the tall, steel skeleton frame buildings withstood the effects of the earthquake and the fire is most reassuring, in fact wonderful, and proves conclusively that the best modern practice is directed along correct and efficacious lines.

It is with much pride and personal gratification that I can report to you, in all fairness to other methods and materials, that the fire-proofing work erected under the Roebling patents fulfilled every expectation, and made a magnificent showing in all cases. Local architects and engineers, and many others who have visited the stricken city, recognize its merits and are thoroughly convinced of its superiority. Large contracts have already been awarded for replacing and repairing other methods by the Roebling systems.

The interesting developments and the lessons of the disaster are set forth in detail in the report. As in the Baltimore fire, the contents of many of the fire-proof buildings would have been preserved had the openings in the outside walls been properly protected. Immediately after the fire I urged the neces-

sity of protecting the openings in the strongest possible terms. The National Board of Fire Underwriters also pointed out the importance of these safeguards and fixed the insurance rates accordingly. Yet, strange to say, in the new building code of the city of Baltimore the protection of the openings in fire-proof buildings is not made mandatory!

The utter disregard of this important detail in the design of fire-proof buildings is further illustrated by the fact that 95 per cent. of these buildings that are now being erected all over the country have no fire-resisting appliances or protection for the openings. This means that their entire contents and finish are in constant jeopardy and liable to be totally destroyed if an adjoining building should be attacked by fire.

The San Francisco fire has again clearly and unqualifiedly demonstrated the dire necessity of protecting the openings of the fire-proof buildings. If fire-resisting barriers are not provided for the openings in these buildings in the future, the gross neglect will assume the proportions of a national disgrace, and every conflagration will but serve to reveal the incompetency and stupidity of the designers.

In collecting the necessary data and in preparing this report, much valuable and efficient assistance was given by the local representative of the company, Mr. P. R. Stuart, who accompanied me each day.

The excellent photographs from which most of the illustrations were made were taken by R. J. Waters & Co., whose efficient and painstaking coöperation I gladly acknowledge. I also wish to acknowledge my indebtedness to Jeremiah F. Dinan, Chief of Police, for many courtesies in connection with the public buildings of the city, and to Mr. P. H. Shaughnessy, Chief of the Fire Department, for favors shown.

My grateful acknowledgments are also due Messrs. Mahoney Bros., Burnite & Bates, A. A. Cantin, M. J. Lyon, A. Reuf, W. Lindgren, S. V. Mooney and J. H. Gray for valuable information and many personal favors.

Respectfully submitted,

A. C. Himmelwright

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INTRODUCTION

THE recent disaster which befell the city of San Francisco is appalling in its extent and its consequences. Following so closely on the heels of the Baltimore, Boston and Chicago conflagrations, it should prove a wholesome object lesson to other municipalities and have a salutary effect on the buildings of the future.

The interesting facts and exact information that have been elucidated should prove of inestimable value, not only to San Francisco, but to the entire civilized world. Many of the defects and omissions in the design of the San Francisco buildings exist also in similar buildings throughout the country. The same results would therefore obtain in a conflagration, if remedial steps are not taken.

In Baltimore, two years ago, it was demonstrated that buildings could be so constructed as to be absolutely indestructible by fire. The same fact has again been more conclusively proved in San Francisco, together with the additional and equally important fact that such buildings can also be designed to successfully withstand earthquakes.

If architects and designers will but heed and profit by the lessons which have been vouchsafed to them at the expense of hundreds of millions of dollars, the buildings of the future will be impregnable against earthquake and fire, will form valuable barriers and bulwarks in fighting future conflagrations, and become havens for safe retreat in similar visitations.

THE ROEBLING CONSTRUCTION COMPANY.

THE SAN FRANCISCO EARTHQUAKE AND FIRE

THE earthquake which visited the coast section of California, and the resulting three days' conflagration in the city of San Francisco, together with fires in other cities and towns within the affected region, constitute a disaster that is unparalleled in modern times.

The vast loss of property and the damage to it will probably reach the enormous sum of a billion of dollars. This does not include consequential losses such as rentals, wages, interrupted business, etc. These losses are difficult to estimate and will continue for ten or fifteen years until the burned district is rehabilitated. The losses actually covered by insurance are placed at two hundred millions of dollars.

While these figures are so vast as to be almost beyond comprehension, they nevertheless fail to give even an approximate idea of the devastation, the ruin, the misery and the suffering that followed in the wake of the disaster.

THE EARTHQUAKE

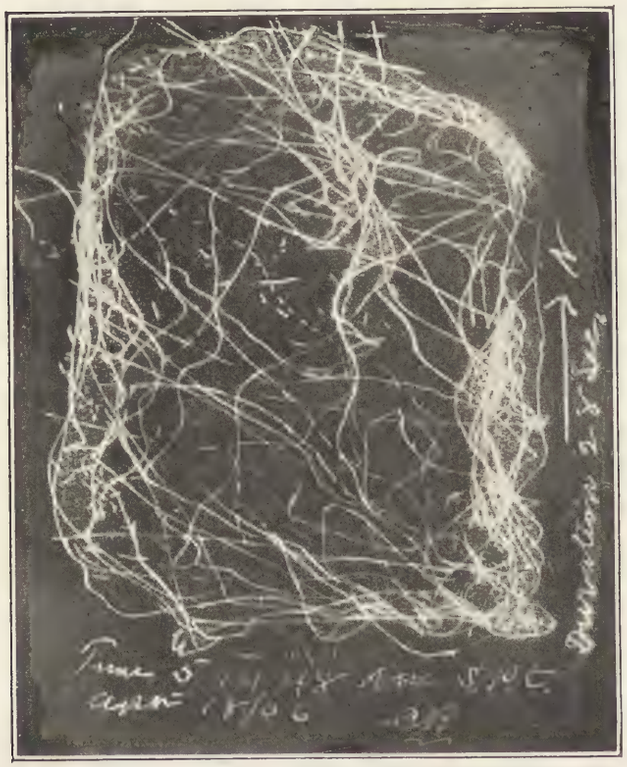
Geology teaches that the earth's crust is constantly undergoing an adjustment of stress and strain, due to the contraction of the surface by cooling.

There are certain localities that in the past have developed lines of weakness where elevations or depressions have caused portions of the crust to slip past each other, the contact surfaces of these movements being termed "faults." The surface manifestations or movements due to these displacements or slips along fault lines are called earthquakes.

Certain sections of the earth's surface, as California and Japan, for instance, possess numerous fault lines of this character, and are much more liable to crustal movements than other sections where these faults do not occur. Earthquakes are therefore natural phenomena and seldom cause loss of life, except indirectly, as when buildings collapse, etc.

California has been the seat of considerable crustal and volcanic activity in the geological past. It contains a number of extinct volcanoes, Mt. Shasta in the northern part of the state being perhaps the most noted, and

having the most extensive lava beds surrounding it. Crustal movements have been frequent, as is abundantly proven by the numerous fault lines which are parallel to the predominent mountain ranges traversing the state. The span of human life is, however, so short comparatively, that only the violent shocks of 1868 and of 1872 can be recalled, even by persons of advanced years. It is unfortunate that no attempt was made until recently to keep accurate and scientific records of these phenomena.



SEISMOGRAPHIC RECORD of the earthquake at the Chabot Observatory, Oakland, Cal., by Prof. Charles Burckhalter.

The line of the fault of the earthquake which visited the California coast on April 18, 1906, extends from a point below Chittenden, Santa Cruz County, in a northwesterly direction, touching the coast at Muscle Rock on the western boundary of the San Francisco peninsula, and thence follows the coast line to Point Arena, a total distance of approximately 200 miles. The area affected comprises a strip on both sides of the fault line averaging 50 miles in width, or about 10,000 square miles. Within this area all structures and public works were more or less damaged, the injury varying from a few cracks in the plaster finish to total collapse and destruction. The effects of the earthquake were most violent in close proximity to the fault line and decreased in intensity in proportion with the distance from it. The city of San Francisco occupied a central position on the fault line and consequently felt the maximum effect.

The main shock occurred at about 5.15 A. M. It was accompanied by a loud, crashing, rumbling noise, caused by the creaking and cracking of timbers, the precipitation of chimneys, cornices, etc., the falling of loose and fragile articles and human voices. There were subsequent minor shocks at 5.19, 5.21, 5.26 and 5.43, with a sharp shock at 8.14 A. M. The duration of the main shock is given at from 28 to 40 seconds at different points along the line of the fault.

The accompanying illustration is a record by the seismograph of the Chabot Observatory at Oakland, Cal., by Prof. Charles Burckhalter. This record is made by a tracing point, which is independent of the earth's movement, on a chart which moves with the surface. The instrument magnifies six times, so that the actual movement of the earth's surface would have been recorded

within a rectangle about $\frac{1}{2}''$ x $\frac{5}{8}''$. The sudden and jarring motion of the earth's surface can, however, be easily imagined by the number and position of the lines traced within the short time of 28 seconds.

The earthquake was sufficiently violent to awaken everyone who was asleep at the time. Pictures hanging on the walls were reversed; pianos, beds and other articles of furniture on casters moved away from the walls. Safes and top-heavy furniture were overthrown, and clocks, bric-à-brac, ornaments, dishes, books, etc., were thrown from mantels and shelves.

The effect of the earthquake was to shake down about 95 per cent. of all the chimneys within the area affected. Many of these chimneys broke through the wooden roofs and fell within the buildings, frequently causing loss of life and much damage. In a few instances the chimneys were broken loose at the roof level and were turned part way around, remaining in this eccentric position after the earthquake subsided. The Dewey Monument in Union Square, San Francisco, had the four upper joints of its granite shaft loosened and slightly shifted to the east, but it still supports the bronze life-size female figure at the top.

The great majority of the buildings in the affected area were two to four stories in height with shallow foundations. When erected on compact, original soil, there was little damage or displacement to the foundations; but when located on soft, incoherent material, the foundations were invariably more or less displaced and the building tilted out of plumb.

Well designed and executed wood or "frame" buildings were but slightly injured by the earthquake. The toppling over of the chimneys and cracks in the plaster finish and cellar walls usually represented the total

HALL OF RECORDS. San José. Showing a section of stonework and brick backing that was shaken out of one of the dormer windows by the earthquake.

EARTHQUAKE DAMAGE. San José. The upper view shows the wreck of a portion of the plant of the San José Gas Company. The lower view shows the collapse of a large building on the southwest corner of Santa Clara and Third Streets, which had brick walls to the second story level and was built of wood above.

damage. Sometimes such buildings were shifted a trifle from their original positions on the foundations. Even where the foundations were affected, the damage was generally confined to plaster cracks and a slight racking of the frame, and was always less than in the ordinary brick or stone walled structures. "Balloon" or continuous frames showed the best results. When the different stories were framed separately and well tied and braced, the results were equally good. The few frame buildings that collapsed lacked suitable ties and braces, or were of flagrantly poor construction.

HALL OF JUSTICE. San José. Showing earthquake damage to the parapet walls and overhanging cornices. This damage is characteristic of over 50 per cent. of the business buildings in San José.

Buildings with masonry walls of stone or brick generally sustained considerable damage. The chimneys, parapet and gable walls and all corbelled-out or overhanging cornices were invariably shaken down. In the cities and towns this damage was very general, every building having a mass of brick or stone work lying around the outside walls at the ground. Where the workmanship was particularly bad, or where the foundations were materially displaced, entire walls were shaken down, causing the collapse of the floors and the complete destruction of the buildings. Many lives were lost from this cause. High factory chimneys were in all cases broken off midway from the top.

The buildings designated as "Class B" in the San Francisco building ordinance had brick, stone or other incombustible walls, with wood floors, supported by metal framing. They were built to heights of six and eight stories. The walls were generally bearing walls with the steel-work anchored to them. Occasionally steel rod ties were also used. The foundations were necessarily much deeper and more substantial than in the case of the smaller buildings, and consequently they were less affected by the earthquake. The superstructures, however, in most cases were seriously damaged, particularly where the walls were not well tied together and where the foundations were displaced.

In many of the so-called "fire-proof" buildings, the walls were self-supporting, being simply built around the steel frame which supported the floor loads. In these buildings the walls were sometimes shaken loose from the steel wall columns and occasionally fell out or remained in a dangerous condition.

RESIDENCES. Howard Street near Seventeenth Street. The upper view shows two buildings that have been tilted badly out of plumb by the earthquake. The rear portions of the buildings settled about 10 feet. The telegraph poles are approximately plumb. Note the building on the right, the corner of which has broken into the side of the tilted one.

The lower view shows Howard Street, looking west. The front of the two buildings shown in the upper view are approximately in the centre. One building near the left-hand side has tilted away from the street line until it almost disappears.

EARTHQUAKE EFFECT. A fissure on East Street near the water front. Note the settlement of the street surface as shown by the exposed curb at the right hand side. In this locality the ground was "made," or artificially filled in.

EARTHQUAKE EFFECT. Distortion of the surface of Mission Street near Seventh, showing the southeast corner of the United States Post-Office Building at the left hand side.

Buildings with steel skeleton frames and curtain walls (*i. e.*, walls supported by the steel frame) generally sustained the earthquake shock without structural damage. These buildings, midway between the top and the bottom, sometimes showed characteristic X cracks in the wall piers between the window openings, indicating that that portion of the structure was subjected to abnormal strains, and through structural flexibility the top part of the building was unable to follow the movements of the base. A racking motion therefore resulted, causing the cracks. The failure of the chimneys at mid-height was no doubt the result of the same cause.

The physical effects of the earthquake were also very noticeable in surface movements. Fences that were originally in a straight line, sometimes had offsets as much as ten to fifteen feet, and there were elevations and subsidences throughout the entire length of the fault line.

Great damage was sustained by water works in the rupture of mains, and the injury to reservoirs, plants and equipments. Elevated water tanks supported by steel and timber framing were frequently wrecked. The railways also suffered enormous damage through displacements of the roadbed and serious injuries to the bridges. The surface movements were very much more apparent in the cities and towns where the alignment of the streets, railway tracks, pole lines, etc., were materially altered. Street rails were severed by tension in some places and buckled at others. Large areas, constituting many acres, settled as much as from ten to fifteen feet, badly distorting the buildings which did not have deep foundations.

A careful analysis and study of the effects of the earthquake indicate that the motions were largely in a horizontal plane and slightly rotary. It is evident that the whole region affected moved generally as a unit, and that the sudden and jarring motions had the effect of causing local disturbances and displacements wherever the soil was soft, incoherent and deep, as in the river bottoms, artificially filled areas, etc. Marked disturbances and deformations of the softer material always resulted along the lines separating a hard, compact material from one that was soft as, for example, the line of contact of the rock formations with the silt of the valleys.

THE FIRE

Immediately after the main earthquake shock on the morning of April 18th, numerous fires occurred throughout the stricken area. These generally emanated from collapsed buildings, and in the larger cities and towns sometimes consumed entire blocks before the flames could be checked.

In the city of San Francisco there were a dozen or more of these incipient fires in as many different locations, most of them being in the business section of the city.

CHIMNEYS. All that remains of many magnificent residences are the chimneys. The top portions of most of these chimneys were shaken off at the roof level by the earthquake before the fire, which accounts for the ragged appearance of the tops. Chimneys of smaller size and poor workmanship were generally overthrown in the fire.

The fire department, celebrated all over the world for its efficiency, was immediately at hand, but found on attaching the hoses to the plugs that there was no water. Plug after plug was tried in the vicinity of the fires, but all in vain, the mains had been broken. In the meantime the fires spread with great rapidity, fanned by a high wind. The helplessness of the firemen was maddening, and to add to the confusion it was discovered soon afterward that the veteran chief of the Fire Department, Mr. Dennis Sullivan, had been fatally injured beneath the fallen walls of the California Hotel.

It soon became apparent that a conflagration of great magnitude had started. The military post at the Presidio was called upon for assistance, and in a short time the city was under martial law.

For three days and two nights the fire raged with incredible fury, destroying everything in its path as it was driven by the wind first in one direction and then in another. The destruction of the entire city was threatened. Citizens were deputized to increase the police force, and troops were hurried to the city from every available source to preserve order. Drastic measures became necessary, and an effort was made to check the progress of the flames by the use of dynamite. "Back firing" was also resorted to in a number of cases, but all to no avail. As a last resort, the wide streets, parks and the water front were used as lines of resistance, and with favorable changes in the wind, the destruction was finally stopped.

It is impossible to describe in language the conditions after this catastrophe. Practically the entire business and financial section of the city was destroyed. All the transportation and communication lines were paralyzed, and half a million human beings, dependent upon two hundred thousand wage earners, were homeless and destitute. Families and friends became separated and it was impossible to communicate with each other or with the outside world. The area devastated comprises that section of the city in which the largest, costliest, and most substantial buildings were located.

Very rigid regulations were immediately inaugurated by the authorities. Lights were not permitted at night. All cooking was required to be done in the streets until the flues could be inspected and passed on by proper officials.

Relief measures were also quickly instituted. The homeless were sheltered in tents which were pitched in the parks and in the Presidio Reservation. Large sums of money were appropriated by the national government and contributed by the different cities, by the business and charitable organizations and societies, and by individuals. Ample provisions and supplies were thus provided for all the destitute, and famine and panic were averted.

About 250,000 persons dependent upon business and financial interests temporarily left the city. About 435 human beings lost their lives and 3,500 more were seriously injured.

MAP of the northern end of the San Francisco peninsula. Showing the area included in the city and county of San Francisco. The section shown in black represents the burned district. The smaller area in white within it shows the relative size of the area destroyed by the Baltimore fire.

THE EFFECTS OF THE FIRE AND THE EARTHQUAKE

In a disaster of such magnitude, in which every type of building and numerous engineering works have been subjected to the two most destructive agencies known, a rare opportunity is presented to study the efficiency and merit of the different materials, as well as the methods of employing them. To the architect, the engineer and others interested in improving the methods of building construction, and who are ever seeking for that which is best and most economical, a vast field for observation, study and reflection is afforded. Defects, omissions and mistakes in design and execution stand out glaringly so that "he who runs may read." Skillful designs and good workmanship, on the other hand, everywhere fulfill expectations and show good results.

The shaded section of the map shown on page 24 represents the burned district. Its area is about 4.11 square miles, which exceeds the combined areas swept by the Baltimore, Chicago and Boston fires of former years. It comprised 514 city blocks with 200 miles of street frontages. Within this area everything combustible was consumed. The wind fanned the embers until every vestige of woodwork disappeared and then blew away the ashes. So complete was the combustion that even the odor of smoke and soot was absent. The heat of the burning buildings was so intense that the stone paving blocks of the streets were frequently scaled and spalled over large areas.

The character of the buildings in the burned district varied greatly, and the manner in which they were affected by the earthquake and the fire was correspondingly different. For convenience in discussing them, they will be divided into two general classes: (1) The Non-Fire-proof Buildings and (2) The Fire-proof buildings.

THE NON-FIRE-PROOF BUILDINGS

In this classification are included all the buildings in which the floors and roofs were composed of combustible materials. Almost the entire city is composed of these buildings, and they occupied the greater portion of the burned district. These structures ranged from the workman's simple one-story cottage to the pretentious office building and hotel.

The wooden buildings completely disappeared, leaving nothing but the fallen chimney to mark the site.

Buildings with brick or other masonry walls and wood beams fared little better. Nothing was left of the interior, and the exterior walls were generally overthrown while the structure was burning. Occasionally portions of the walls remain standing, but in a weak and tottering condition.

The Class B buildings developed even less fire resistance than those without metal frames. When these buildings were attacked by fire they were totally wrecked. The burning of the wood floors in all cases caused the failure of the metal frames which collapsed into a twisted, tangled, shapeless mass in the interior of the building. The metal frame being anchored to the walls usually pulled them down when it collapsed, or pushed them outward, when they fell on adjacent buildings, causing enormous damage and destruction on account of their great height.

The general failure of the walls of the non-fire-proof buildings filled a large portion of the burned district with brick and mortar *débris* to an average depth of about 4 ft., completely obliterating street and property lines and obstructing the streets so that they were impassable except for pedestrians.

Occasionally buildings of superior workmanship and materials showed better fire resistance, and some of these are described in detail elsewhere. A few non-fire-proof buildings escaped destruction in the burned district by fortuitous circumstances. One other (the California Electrical Co.'s Building), built in accordance with the rules of the Massachusetts Mutual Fire Insurance Companies, was equipped with a sprinkler system and fire-resisting barriers at the openings, and thoroughly demonstrated the value and efficiency of these safeguards. The detailed descriptions of the most important of these buildings follow:

Palace Hotel.

S. W. Cor. Market and New Montgomery Streets.

John C. Gaynor, Architect. Sharon Estate, Owner.

Details of Construction:

This is a large seven-story structure, and was one of the celebrated hostelries of San Francisco. It covered an entire city block. The walls are of brick built in a first-class manner, and rigidly tied together by steel bars. All the interior dividing walls are also of brick, not less than 13″ in thickness. The wood floors were generally supported by the walls, but in some cases by steel girders.

Effects of the Fire and the Earthquake:

The foundations evidently are first-class, as there is no apparent damage to them. The walls remain practically plumb, show only a few slight earthquake cracks, and are apparently in good condition. The entire interior of this building, which consisted of wood flooring and finish, has completely disappeared, leaving nothing but the walls and girders.

Sutro & Co. Building.

East Side of Montgomery Street, near California Street.

This is a small three-story building with brick walls and wood floors. It stands adjacent to the Kohl Building, and the rear is protected by the Mercantile Trust Building.

The wind blew in a favorable direction at the time that the other buildings were consumed in this neighborhood. This building was protected on two sides by fire-proof buildings and presented a blank brick wall with a parapet on the third side which faced the other buildings of similar construction that were consumed. Owing to these fortunate circumstances it escaped without damage.

Parrott Estate Building.

N. W. Cor. California and Montgomery Streets.

Stephen Williams, Architect.

This building was erected in 1853 by Chinese labor, and the granite was imported from China. It is three stories high. The backing of the granite facing, and the rear walls are of common

THE PALACE HOTEL. Northwest Corner of Market and New Montgomery Streets. The exterior walls are of brick, well tied by steel rods and bands. The interior dividing walls or partitions are also of brick. The floors and interior finish were of wood. The excellent design and workmanship of the walls prevented any material damage by the earthquake. Fire consumed the wood floors and all the combustible contents, leaving only the walls, which remain in good condition. It is the best preserved building of the non-fire-proof type in the burned district.

brick. The floors and interior columns were of wood. It has a first-class foundation, and the materials and workmanship are considerably above the average for this class of building.

The fire spalled the 4″ granite facing around the window openings, and the entire interior of the building was consumed. The walls, however, show very little structural damage, and illustrate in a very marked manner the superior results of good construction. A sample of the mortar that was inspected was evidently gauged with Portland cement.

Other buildings of the same character around it were completely wrecked by the earthquake and the fire, and are in ruins.

Folger Building.

S. W. Cor. Howard and Spear Streets.

Henry A. Schultz, Architect. J. A. Folger, Owner.

The Folger Building is a large four and five story building, with brick walls and wood posts and floors, that miraculously escaped from the fire. It has pile foundations.

It is at the edge of the burned district, and owes its preservation to the fortunate change of wind at the critical moment, when it was about to be ignited. This building was very little damaged by the earthquake, about one-half of the parapet wall on the south side having been shaken down.

The street level settled about 2 ft. at the northeast corner of the building, but there are no earthquake cracks visible in the walls at this point.

Montgomery Street and Taylor Street Blocks.

The Montgomery Street block was bounded by Clay, Washington, Sansome and Montgomery Streets. The buildings of this block were of ordinary construction, some of them being built wholly of wood. They were generally two, three and four stories in height. On account of changing winds and various other accidental circumstances, this block escaped the fire.

The Taylor Street block was bounded by Taylor Street, Broadway, Jones and Greene Streets. It also escaped the fire, although standing in the midst of the burned district in this part of the city.

California Electrical Works.

N. W. Cor. Folsom and Hawthorne Streets.

F. F. Sewell, Architect. California Electrical Works, Owner.

Details of Construction:

This is a large four-story building of the "slow burning" type, having brick walls and heavy wood floors and roof. The fronts are ornamented with sandstone. The cornice is of galvanized iron. All the window openings were supplied with Forderer metal frames and sash, with wire glass glazing, except four windows on the fourth floor which were glazed with plate glass and protected with corrugated steel shutters.

The east side of the building is a blank brick wall, the only door opening being equipped with double, metal-covered, standard underwriter's doors. All the walls are laid in cement mortar and rest on spread concrete footings. All the stairways and elevator shafts are enclosed in brick walls.

The building is equipped throughout with an automatic sprinkler system. A 50,000-gallon tank to supply the sprinkler system is located on the roof. A covered tank with a capacity of 120,000 gallons is also available and is located under the shipping area at the rear of the building.

In the design and the equipment of this building, the rules and requirements of the Mutual Fire Insurance Companies of the State of Massachusetts, for factory buildings, were complied with. It was probably the only building that complied with these rules within the burned district.

Effects of the Fire and the Earthquake:

This building stands alone, the fire having consumed all the other buildings around it. Its escape from the flames is due exclusively to the efficient protection of the window and door openings throughout.

A four-story warehouse of similar construction, except that the openings were unprotected, occupied by Waterhouse & Price, located just west of this building and about 30 ft. distant, was entirely consumed.

Between the two buildings, piled to the height of the second-floor level, was a large quantity of wooden cross-arms. The burning of these cross-arms, and the Waterhouse & Price ware-

house, furnished a severe fire test for the metal window frames and sash and wire glass. The glass was cracked quite generally on this exposure, and the metal frames and sash were blistered. Putty ran out of the seams, but the wire glass remained in place and prevented the flames from entering the building.

On the north side of the building the earthquake shook down a section of the parapet wall and the main wall to a point two feet below the roof level, and exposed some of the wood-work. This was ignited when the conflagration reached other buildings fronting on this side, but the flames were put out by employees.

The two metal-covered doors protecting the door openings on the east side fulfilled their purpose admirably, the door on the side facing the fire being practically destroyed, but the inner door remaining intact and but little damaged.

Excepting the damage to the top of the wall on the north side of the building, the exterior walls are uninjured. This building was occupied as before the fire at the time that it was inspected.

Comments:

The wisdom of protecting the window and door openings, even in a building which does not have an incombustible interior, is thoroughly demonstrated by this building. The fact that fire-resisting barriers can be provided for the window and door openings, without disfiguring the buildings, is also shown by this example. It is an object lesson so plain and so convincing that it should appeal not only to architects and engineers, but to business men and owners as well. This, and similar treatment of the openings, has been urged in the strongest possible terms by the National Board of Fire Underwriters, insurance experts and others ever since the Baltimore fire. The efficiency and advantage of fire-resisting barriers in the door and window openings was also demonstrated in that conflagration.

All buildings of fire-proof construction, and in fact all buildings with masonry or other incombustible walls, should have the openings protected by fire-resisting barriers. The additional cost to provide these safeguards is more than compensated for by the reduced insurance.

As fire did not enter this building, the temperature within was never high enough to operate any of the automatic sprinklers. The available independent water supply was a valuable safeguard, and was utilized by employees in extinguishing the fire at the roof level in the rear where the earthquake had exposed the wood-work.

It is noteworthy that the burning of the buildings on the opposite side of the street, which is about 85 ft. wide, did practically no damage to the windows on this side of the building.

Business in this building was only suspended a few days during the fire. The repairs will be insignificant and will be limited almost exclusively to reglazing and repainting the windows on the west side of the building and restoring the brick parapet wall in the rear.

PANORAMIC VIEW of the portion of the San Francisco burned district containing the fire-proof buildings.

1. Pacific States Telephone and Telegraph Company's Main Office, Bush Street near Grant Avenue.
2. Union Trust Building, Corner Montgomery and Market Streets.
3. Wells Fargo Building, Mission and Second Streets.
4. Crocker Building, Junction of Post and Market Streets.
5. Sloane Building, Post Street between Kearny Street and Grant Avenue.
6. Shreve Building, Corner Post and Grant Avenue.
7. Chronicle Building (New Addition), Corner Kearny and Market Streets.
8. Monadnock Building, Market between Third and New Montgomery Streets.
9. Mutual Savings Bank, Junction of Geary and Market Streets.
10. Spreckels or Call Building, Corner Third and Market Streets.
11. Aronson Building, Corner Third and Mission Streets.
12. Kamm Building, Market Street near Third Street.
13. Whitehall Building (Skeleton), Geary Street between Grant Avenue and Stockton Street.
14. Spring Valley Building, Corner Geary and Stockton Streets.
15. The Dewey Monument, Union Square.
16. Butler (Newman & Levinson) Building, Corner Geary and Stockton Streets.

PANORAMIC VIEW of the portion of the San Francisco burned district containing the fire-proof buildings.

17. Hotel St. Francis (and New Annex in the course of construction), Corner Powell and Geary Streets, opposite Union Square.
18. Hotel Alexander, Geary Street between Powell and Mason Streets.
19. James Flood Building, Corner Powell and Market Streets.
20. Hotel Hamilton, Ellis Street between Powell and Mason Streets.
21. United States Mint, Corner Fifth and Mission Streets.
22. California Casket Company's Building, Mission Street between Fifth and Sixth Streets.

MAP showing the burned district of the City of San Francisco. The shaded portion shows the area consumed. It comprises $4\frac{11}{100}$ square miles and 514 city blocks.

THE FIRE-PROOF BUILDINGS

The only buildings in the burned district that retained any semblance of their original condition after the fire were the fire-proof buildings. In these, the walls, floors, roofs and partitions are of incombustible material, and the floor loads are supported by protected steel framing. These buildings stand out prominently amidst the ruins and destruction of all the other buildings. Their exteriors are seared and scarred, but all of them remain standing and intact, mute monuments to the superiority of modern methods of construction.

Fire was communicated to the interiors of the fire-proof buildings, without exception, when neighboring combustible buildings were consumed, the flames entering through the unprotected window openings and spreading upward from story to story by the burning of the wood frames and sash.

The wood finish and all the combustible contents of these buildings were generally destroyed. Much of the incombustible finish and ornamentation was also irreparably damaged. All exposed metal work, such as elevator framing and fronts, stairway strings, piping, ornamental iron, mail chutes, etc., was permanently deflected and buckled out of line. *Débris* consisting principally of plaster and hollow tile blocks frequently covered all the floors to a depth of from two to eight inches, and in many cases the impact of the blocks and the abnormal loads wrecked the stairways.

The material employed for the fire-proof floors in these buildings was of two general classes: (1) the burnt clay products, such as hollow tile, brick, etc.; and (2) concrete, with either cinder or stone aggregates. The former materials were used in 15 buildings, and the latter in 61.

In order that each building may be carefully studied, and to enable the reader to form his own conclusions, detailed descriptions, with illustrations, follow:

Hobart Building.

North Side of Market Street, between Montgomery and Sansome Streets.

Edw. R. Swain, Architect. Hobart Estate, Owner.

Details of Construction:

The Hobart Building is five stories in height, and was used for stores and offices. The façade consists of gray granite for the first story and common brick with granite ornaments above. The side and rear walls are of common brick. The walls are bearing walls. The metal frame is of cast iron with steel girders and beams.

The fire-proof floors are the ordinary rowlock segmental brick arches in some parts of the building and segmental arches of brick concrete 4″ thick elsewhere. The spans are generally 5′ to 6′ between beams. A flat ceiling of wire lath and plaster was erected underneath the arches. There was no con-

HOBART BUILDING. Market Street, between Montgomery and Sansome Streets. The façade consists of gray granite for the first story and common brick with granite ornamentation above. The granite is badly spalled on the west side at the first-story level, but the front is little damaged elsewhere. The interior is in bad condition, large sections of the flooring having collapsed on account of exposed girders and beams in the basement. The steel framework is badly distorted and warped. The fire-proof floors consist of segmental arches of common brick and brick concrete, with flat wire lath and plaster ceilings underneath. The partitions and column protection are of hollow tile blocks. A large proportion of the partitions are wrecked. The column covering is in fair condition. The flat wire lath and plaster ceilings failed in many places on account of a supporting clip of poor design.

HOBART BUILDING. First floor. View from the sidewalk at the front of the building. A hot fire in the basement caused the excessive deflection of the unprotected girders, which pulled away from the flimsy column connections, permitting the greater portion of the first floor to fall into the basement. The column protection is of metal lath and plaster in the first story, and of hollow tile 2″ in thickness in the upper stories.

HOBART BUILDING. Fourth Story. Showing the failure of the hollow tile 3″ and 4″ partitions, and of the hollow tile protection around the vaults. The column protection was of two-inch hollow tile blocks. The workmanship and material being of a better grade than that of the partitions, in many cases the column protection is but slightly damaged where the partitions are completely wrecked around it.

HOBART BUILDING. Fourth Floor. Showing the tops of the deflected and warped floor beams, which projected above the segmental brick arches. The regular concrete filling between the floor arches and the wood floor finish was omitted. The burning of the wood floor heated these unprotected beams sufficiently to distort them as shown.

crete fill over the arches; the space between the wood floor finish and the top of the segmental arches being left hollow. The cast-iron columns are protected with common brick in the basement, with metal lath and plaster in the first story and with hollow tile blocks 2″ in thickness in the upper stories. The partitions are of 3″ and 4″ hollow tile blocks. The floor beams of the ground floor rest on top of exposed girders.

Effects of the Fire and the Earthquake:

The west side of the first floor of this building was occupied by a sporting goods concern, and in this part of the building there are evidences of an intensely hot fire. The granite columns at the front of this store are spalled and cracked into fragments, and temporary wood posts have been set in their places to support the lintels and mason work above. The granite ornamentation in the front is spalled in numerous places and considerably damaged, but the common brick in the front are but slightly injured. The metal cornice is badly damaged. The first story floor in the front portion of the building has fallen into the basement. In the second story at the S. W. corner a safe fell over, breaking out two panels of flooring and deflecting the beams in two bays. In the third story, a safe in the S. W. corner fell on its side and broke a hole in the floor, but did not drop through. On account of the space between the wood floor finish and the arches being left vacant, a part of the web and the upper flange of the beams were generally exposed and the burning of the wood floors was sufficient to heat the beams so as to cause them to deflect and warp out of line. The wire lath and plaster ceilings fell in many places on account of a poorly designed clip supporting it. This clip was L shaped, of ½″ x ⅛″ light steel, and was bolted to the furring of the ceiling in such a way as to project over the lower flange of the beam and thus support the ceiling. The 3″ and 4″ hollow tile partitions were badly damaged, about 60 per cent. of the blocks having fallen down. The 2″ hollow tile column protection was of much better quality, and generally remained in position. The 3″ and 4″ partition blocks frequently failed and fell away from the column protection, leaving it standing intact. The cast-iron stairs and elevator fronts are completely destroyed in the first story and badly damaged above.

Comments:

The failure of the first floor was due to a hot fire in the basement, causing excessive deflection of the unprotected girders, which pulled away from the columns and walls and fell into the basement. The hot fire in the sporting goods store caused the collapse of the story above it in the same manner, some of the deflected girders of the second story remaining partly in position in the rear.

While the exterior of this building is not so seriously damaged but that it can be repaired, the steel frame work is so badly wrecked and deflected by the heat that it will probably be necessary to reconstruct the entire interior. In a building of this height, where the three remaining walls are of common brick, it is a question whether it will not be an advantage to the owners to replace this structure by a new one which could, no doubt, be made a number of stories higher.

The mistake in omitting the concrete filling over the arches, flush with the top of the floor beams, which protects the upper portion of the beams, is clearly pointed out in the case of this building. The error of not providing a good type of fire resisting ceiling or other protection to the soffits of the beams and girders is also responsible for some of the steel failures in this building.

Union Trust Building.

N. E. Cor. Montgomery and Market Streets.

Clinton Day, Architect. Union Trust Co., Owner.

Details of Construction:

This building is ten stories in height, and was used as an office building. The façades are of gray granite for two stories and terra cotta and terra cotta pressed brick for the stories above. The cornice is also of terra cotta. The metal frame is of steel, the walls being self-supporting.

The fire-proof floors are of hollow tile, the arch blocks being end construction, 10″ in depth, with skewbacks of side construction. The shells and webs are ⅝″ and ½″ in thickness respectively. The soffits of the beams are protected by a soffit slab supported by the skewbacks; the girders are protected by special hollow terra cotta blocks, with the soffit covering similar

UNION TRUST BUILDING. Northeast Corner Montgomery and Market Streets. The exterior of this building is but slightly damaged, having been exposed to only a moderate fire. The granite of the first and second stories is spalled around the window openings, the greatest damage having been wrought on the Montgomery Street side. The principal structural damage to this building was caused by the failure of a hollow tile suspended ceiling which admitted the flames to the blind space between the ceiling and the roof, causing the injurious deflection of a large portion of the roof framing. The hollow tile floor arches throughout are in fair condition. The soffits have fallen away in numerous cases, exposing the cellular spaces, and a few spans between beams have been broken down by falling safes. The hollow tile partitions are badly damaged, and a large proportion has fallen down. The hollow tile column covering is off in many places, exposing the columns, the piping within the protection being responsible for much of the damage.

UNION TRUST BUILDING. Seventh Story. Typical view of the damage to the hollow tile floors, partitions, column covering, and wall furring. The safe in the foreground has been moved to a secure position over a girder. The safe in the centre has been moved into the doorway through the party wall between the old and the new parts of the building.

to the beams. A 4″ cinder concrete fill and 2″ of sleeper fill was laid over the arches.

The partitions and the column covering are of hollow tile blocks, 3″ and 2″ in thickness respectively. The floor finish was generally of wood, laid over sleepers and sleeper fill. The hallways were finished in granolithic or other incombustible finish.

Effects of the Fire and the Earthquake:

The Market Street front is in good condition, the granite around the window heads being slightly spalled. Some of the ornamental terra cotta is also slightly spalled. The cornice is very little damaged. On the Montgomery Street front, the window openings of the first and second story are badly spalled. The terra cotta and pressed brick above are in good condition, except that a few of the terra cotta brackets under the balconies at the sixth story are down.

The levels on the water table show that the foundations are in good condition. The greatest observed variation of the walls from the plumb is at the northwest corner, where the west wall leans 3/8″ to the west.

The principal fire damage to this building occurred in the tenth story, where the burning of an attorney's library caused a fire of greater intensity and duration than in any other part of the building. The fire in this story caused the failure of the 3″ book tile suspended ceiling, and the flames entering the space between the suspended ceiling and the roof, heated the unprotected roof framing so as to cause large sections of it to deflect badly. The tile blocks of the roof fell out at several places.

The steel supports for the suspended hollow tile ceiling are unusually heavy, carrying 3″ x 3″ x 5/16″ tees at 16″ centres, on the flanges of which the rabbetted 3″ book tiles are laid. The under side of the tees are protected by tile slabs, 3/4″ thick, anchored into dovetail projections of the book tile.

The hollow tile floor arches throughout are considerably damaged. The soffits are broken off in spots, exposing the cellular spaces, and a few arches have been broken by falling safes. The hollow tile partitions are badly damaged, and a large proportion of the blocks are down. The column covering is off in many places, usually wherever piping was enclosed within it.

The elevator fronts and the cast-iron stairway are slightly damaged. The power plant in the basement can be repaired.

Comments:

This building was subjected to only a moderate fire, such as would reasonably be expected from the combustion of the usual wood finish, furniture and furnishings of such a building.

The injury to the exterior is comparatively small and can be repaired. The damaged places in the floors can be replaced by new material. Some of the partition blocks can probably be utilized in rebuilding the partitions.

The steel framing of a large portion of the roof has deflected badly, on account of the failure of the hollow tile suspended ceiling under it, and large sections will require reconstruction.

German Savings and Loan Society Building.

North Side of California Street, between Montgomery and Kearny Streets.

E. Kolefrath, Architect. German Savings and Loan Soc., Owner.

Details of Construction:

This is a two-story bank building of massive construction. The façades consist of gray granite. The west and rear walls are of common brick. The floors are supported by steel framing, the walls being self-supporting.

The fire-proof floors, partitions and wall furring are of hollow tile. The floor finish is in mosaic in the public halls and spaces, the rest of the finish being in wood, laid on wood sleepers and sleeper fill.

Effects of the Fire and the Earthquake:

The front is but slightly damaged by the fire. The east side is spalled around the window openings. The side and rear walls of common brick are in good condition. The hollow tile floors and roof are in fair condition, only a few of the blocks having the soffits off and exposing the cellular spaces. The earthquake disrupted portions of the parapet wall, and in removing these careless workmen permitted a small section of the wall to fall over on the hollow tile roof, breaking a hole through it and through the floor underneath, dropping entirely through to the basement. The hollow tile protection of the large girders sup-

UNION TRUST BUILDING. Top Story. Showing the deflected steel work of the roof and hung ceiling, also the damage to the hollow tile partitions, column covering, and the book tiles of the hung ceiling. The steel work supporting the ceiling was unusually heavy. When the hung ceiling failed, the fire greatly damaged the steel work of the roof construction, causing it to deflect badly. See also a different view of the same story on the opposite page.

UNION TRUST BUILDING. Top Story. Showing the failure of the heavy steel work supporting the hung ceiling, and the damage to the steel framing of the roof. Showing also the condition of the hollow tile column covering and partitions. The additional fuel of an attorney's library is responsible for this damage.

MUTUAL LIFE BUILDING. Southeast Corner Sansome and California Streets. The façade consists of granite for two stories and pressed terra cotta brick with terra cotta ornamentation above. The granite is badly spalled around the window openings, but the terra cotta is only slightly damaged. The upper portion of the building was badly wrecked on account of the collapse of one of the large trusses supporting the roof. This collapse was caused by the failure of the hollow tile partitions which were designed to protect it. The rear walls are considerably damaged by earthquake cracks and the collapse of the roof truss. A normal fire in this building damaged the soffits of the hollow tile floor blocks in numerous places. Many of the partitions have fallen down, and the column protection is badly damaged. Safes from the upper stories broke through the hollow tile floors to the basement.

porting the roof is in fair condition. The large glass dome in the rear of the banking room is uninjured structurally. This was glazed with thick plate glass without wire. Much of the glass is cracked, but only about 15 per cent. of it fell out because of the small size of the panes.

Comments:

There was comparatively little fire in this building. The high dome and the ornamental plaster work of the banking room are only slightly damaged.

Mutual Life Building.

S. E. Cor. Sansome and California Streets.

Clinton Day, Architect. Mutual Life Ins. Co. of N. Y., Owner.

Details of Construction:

The Mutual Life Building is nine stories in height, and was used for offices. The façades consist of granite for two stories, and pressed terra cotta brick with terra cotta ornaments above. The cornice is of terra cotta. The metal frame is of steel, the walls being self-supporting.

The fire-proof floors are 9″ end construction hollow tile flat arch blocks, with skewbacks of side construction. The shells and webs are ⅝″ and ½″ thick respectively. The partitions throughout are of 3″ hollow tile blocks and the wall furring of 1½″ hollow tile blocks. The column protection is of 3″ hollow tile blocks built independently of the partitions. The soffits of the beams and girders are protected by tile slabs anchored to the skewbacks.

The floor finish is of wood laid on sleepers and sleeper fill. The finish in the public halls is of marble tile.

Effects of the Fire and the Earthquake:

This building was subjected to a normal fire only. The granite of both the Sansome and California Street fronts is badly spalled around the window openings, and will require almost total renewal. The pressed terra cotta brick and terra cotta ornaments of the upper stories are in good condition, being only slightly spalled. The west wall face brick are bulged from the backing at the northeast corner, midway from the top, and a large diagonal crack extends from the centre of this wall, at the base, to the south side at the top. There are also small earthquake cracks in the wall of the southeast L extension. The south brick wall is in good condition. The levels on the water table show that the foundations are practically level, there being less than ½″ difference in the elevation of the corners. The greatest observed variation of the walls from the plumb is about ¾″ at the northeast corner, where the north wall leans to the south. At the northeast corner, the east wall leans to the east about ⅜″.

The steel frame work in the lower stories is in good condition. The roof was supported by three large trusses within hollow tile partitions. The latter failed in the fire, exposing the trusses to the heat, causing them to buckle and deflect. The middle truss failed, partially fracturing the top of the wall columns supporting it and falling to the seventh floor. The impact of the steel frame work and roof tiles striking the seventh floor, knocked out four spans of the hollow tile floor arches, which in falling broke down many of the arches of the floors below them. The wreck of this truss bulged the east and west walls badly, so that they are temporarily tied together by cables. The parapet wall on the east side is down.

The floor arches are in fair condition. There are many places where the soffits of the tile blocks have fallen away, exposing the cellular spaces. The partitions are badly damaged throughout, a large proportion of the blocks having fallen down. Safes also caused the failure of some of the floor arches in this building.

The column protection having been set independently of the partitions, is in fairly good condition. Some of it has been forced away by bulging pipes, but the columns are apparently uninjured. The exterior wall furring has fallen off in spots and is loose in many places. The elevator fronts and cast-iron stairway with marble treads are considerably damaged. The steel framing in the elevator shaft is bulged out of line.

Comments:

This building exemplifies very forcibly the necessity of protecting large trusses in an efficient manner. The protection should consist of some material which will remain in place and

MUTUAL LIFE BUILDING. Fifth Story. Showing the openings through the fifth and sixth floors where the hollow tile arches were broken out by a falling safe. The broken tie rods are still hanging from the beams. The pipes on the right hand side were enclosed within the hollow tile column protection, and no doubt contributed toward its failure.

MUTUAL LIFE BUILDING. Ninth Story. Showing a truss supporting the roof in the rear, badly buckled and distorted by the fire. A similar truss in the centre of the building failed, as shown, bending the tops of the wall columns inward just below the gusset plate braces. The connection of the lower cord of the truss remains intact on the right-hand side. When the top cord buckled from the heat, all the load was transmitted to the bottom cord, which deflected and failed, parting at a beam connection and making a clean rupture, as shown, near the centre. These trusses were protected by hollow tile partitions, which failed, a section of one of the partitions remaining back of the rear truss on the right-hand side. The effect of the failure of this truss was to bulge the outside walls, which are now temporarily tied by cables, as shown. The falling of the steel work also knocked out several hollow tile arches, which broke out a great many others below them. The photograph was taken after some of the *débris* had been cleared away.

JAMES FLOOD BUILDING. Powell and Market Streets. The façades are of Colusa sandstone, with a pink granite base to the water table. The damage to the exterior consists of spalling around a number of the window openings and earthquake cracks where the corner tower joins the side walls, and at the northwest corner pier of the Powell Street side at the first-story level. The fire-proof floors are of hollow tile arches, segmental in form, with Roebling flat wire lath and plastered ceilings underneath. The column protection, partitions and wall furring consist of hollow tile blocks. The floors are in good condition, except a section over the central portion in the first story. A fire of greater intensity occurred in this location, causing the failure of the wire lath ceiling. When the latter fell away, the hollow tile blocks above it were damaged by the fire, exposing the cellular spaces over a considerable area. The hollow tile partitions stood as well in this building as in any in the burned district, but about 15 per cent. of the partition areas are down. The hollow tile column protection was badly damaged in many places, but fulfilled its purpose and prevented the failure of the columns.

which can be rigidly anchored to the structural members. The failure of the fire-proof protection of the trusses is no doubt responsible for the entire damage to the two upper stories of the building.

Although the foundations are apparently in good condition, the walls are considerably damaged and extensive repairs will be necessary to restore this building.

James Flood Building.

Junction of Market and Powell Streets.

Albert Pissis, Architect. James L. Flood, Owner.

Mahoney Bros., Contractors.

Details of Construction:

This is a large modern twelve-story store and office building. It has grillage foundations and a steel skeleton frame. The building was completed in 1904. The façades consist of Colusa sandstone with a pink granite base as high as the water table. The cornice is also of sandstone.

The fire-proof floors consist of segmental hollow tile arches, the spans between the beams being 7½ ft. Over the arches is a good cinder concrete fill flush with the tops of the beams. Underneath the floor arches throughout is a flat Roebling wire lath and plastered ceiling, the lath being laced to the ceiling supports with No. 16 B. & S. gauge copper wire. The roof tier consists of the Roebling System B or flat slab construction of cinder concrete about 4″ in thickness. The soffits of the beams of this tier are protected by crimped wire lath and cement plaster.

The partitions are 4″ hollow tile blocks throughout. The columns are of Z-bar section, filled with common brick to the outer edge of the section, and then enclosed by 3″ hollow tile blocks. The soffits of the beams and girders are protected by tile slabs suitably anchored to the hollow blocks.

The floor finish was of wood laid on sleepers and sleeper fill, except in the corridors, which had an incombustible finish.

Effects of the Fire and the Earthquake:

The Market Street front is slightly spalled around the window openings, and is but little damaged by the fire. The window openings are also considerably spalled in places on the Powell Street side, those on the west side at the fifth and sixth stories being injured most. Where the semi-circular tower joins the Market and Powell Street walls, both sides are considerably cracked by the earthquake. The northwest corner pier of the Powell Street side is also racked and shattered by the earthquake. The east half of the Ellis Street front is very badly scaled and spalled. The northeast corner is greatly damaged by the earthquake. The east gable wall of brick is in good condition.

The levels on the water table indicate that the foundations remain level and intact. Observations on the different corners of the building show that the walls remain perfectly plumb. The steel skeleton frame is uninjured.

The hollow tile floors are in good condition throughout, except in the first story and several other smaller spots where the wire lath and plaster ceiling fell away. Where this occurred, the tile blocks are badly damaged, the soffits having failed and fallen away, exposing the cellular spaces. The concrete arches in the roof remain uninjured, and the suspended ceiling underneath is in good condition, a large portion of the plaster still adhering to it.

A larger proportion of the hollow tile partitions remain standing in this building than in any other fire-proof building in the burned district in which this material was used. The partition blocks over door openings have generally fallen down. Large sections of the partitions that are still standing are weak, having been damaged by the earthquake and the fire, and will have to be rebuilt. Only about 10 per cent. of the partition blocks have actually fallen down. In the upper story, where a flat wire lath and plaster ceiling was suspended about 6 ft. below the roof, the partition blocks were carried only to the under side of the ceiling. This permitted the blocks to expand when heated, and the partitions in this story are more stable than in any other. It is particularly noticeable that the blocks over door openings in this story remain solidly in position.

The column covering is in fair condition, being damaged only in spots and fulfilling its purpose sufficiently to prevent any column failures.

One of the most celebrated cafés in the city was located in the basement. This portion of the building was completely fire

JAMES FLOOD BUILDING. Showing the earthquake damage to the northwest corner pier at the first story level.

FLOOD BUILDING. First Story. The columns are protected by filling the re-entrant rectangular space with common brick, and then enclosing them with 3″ hollow tile blocks. The Roebling wire lath was laced to the ceiling furring with No. 16 B. & S. copper wire. The low fusing point of copper wire caused it to weaken, and allowed the lath and plaster to fall away from the supports, exposing the under side of the segmental hollow tile arches to the flames, which seriously damaged them as shown. In other portions of the building where the wire lath and plaster ceilings remain in place, the floor arches above are uninjured. The great height of this story was the cause of more damage to the partition blocks than in the other stories, which were of lesser height. The photograph was taken after much of the *débris* had been removed from the floors.

FLOOD BUILDING. Fourth Story, southwest corner. Showing typical damage to the 4" hollow tile partitions that were built solidly from the top of the fire-proof flooring through the Roebling wire lath ceiling to the under side of the hollow tile arches above. Under these conditions, when the partitions expand from heating, there is a tendency to buckle or deflect, which frequently causes failure. The blocks over the door openings have generally been forced down into the opening, and have dropped out from this cause. Some of the partitions that remain standing are weak and in a tottering condition. This illustration shows also the brick-filled column inclosed by 3" hollow tile blocks. This is an improvement over the ordinary method, but could be rendered still more efficient by filling the space between the hollow tile protection and the steel member solidly with cement mortar, and by providing a separate enclosure for pipes.

FLOOD BUILDING. Tenth Story. Showing the typical condition of the 4″ hollow tile partitions that were built from the top of the fire-proof flooring to the under side of the Roebling wire lath suspended ceiling. The partitions in this story were in much better condition than in the lower stories because the wire lath ceiling acted as a cushion and permitted them to expand when heated. The blocks over the door openings remain in place. This view is taken looking through a row of offices. The loose sheets of wire lath shown in the view have dropped away from the supports, on account of being laced to them with copper wire, which is much weaker for this purpose than steel wire.

swept, damaging all the expensive decorations and ornamental work and the grand staircase to the street. The ornamental work in the banking room in the northeast corner of the building is also damaged, but the safe deposit vaults in the basement are uninjured.

The cast-iron stairways, with marble treads, are but slightly damaged, the injury being confined principally to the marble treads, many of which are broken. The wire lath and plaster ceilings remain generally in good condition, with the exception of the spots already referred to.

The large skylight at the third story level was greatly damaged and the glass broken out by fragments of brick and stone which spalled from the interior surface of the light court above. This light court was faced with brick, bonded every sixth course to the backing, with projecting terra cotta ornaments. The latter spalled quite generally and did the most of the damage to the skylight below. Sash weights from the upper stories also rained down upon the Roebling concrete roof of the light court without causing any damage other than to break one hole about 5″ square through it.

The elevator fronts are bulged out of line and damaged at some places. The electric conduits and pipes in the northeast corner of the building are carried within the same enclosure as the column covering, but first-class workmanship and materials prevented any damage to the columns in this case. The power and mechanical plant in the basement sustained considerable damage.

Comments:

The design, materials and workmanship of this building were as good as any of the fire-proof buildings in the burned district. The foundations remain level and the walls plumb. The damage to the exterior by the earthquake and fire can readily be repaired, as there is apparently no serious structural damage.

This building was subjected to a comparatively moderate fire only, as there are a number of places, especially in the third story, where there is considerable charred wood-work still remaining.

The falling away of the wire lath and plaster ceiling in the first story, where there was as intense a fire as in any part of the building, is due to the fact that the lath was laced to the ceiling supports with No. 16 B. & S. gauge copper wire. Had a mild steel wire (which fuses and weakens at a much higher temperature) been employed, these portions of the ceiling would no doubt have remained in place, and the damage to the hollow tile blocks above would have been prevented.

The advantage of carrying hollow tile partition blocks only to the wire lath and plastered ceiling, instead of through the ceiling against the rigid fire-proof floors or beams above, is clearly shown in the top story, where the partitions remain in better condition than in any other part of the building. When hollow block partitions are erected between rigid incombustible surfaces, there is no opportunity for the material to expand under heat; consequently, when expansion takes place in a fire, the blocks over door openings are forced down into the openings and fall out. The expansion also causes an immediate tendency to buckle or deflect the partitions, which in many cases causes failures sooner than would otherwise be the case.

Parrott Building.

Market Street, between Fourth and Fifth Streets

Albert Pissis, Architect. Parrott Estate, Owner.

Details of Construction:

The Parrott Building, also known as the "Emporium," is a very large building that was originally four and seven stories in height and was occupied as a department store and office building. The three lower stories are of fire-proof construction; the upper floors were of wood, supported by steel columns and girders. The building was planned with a large interior light court approximately 50 ft. in diameter, extending from the third floor level to the roof.

The Market Street façade consists of copper-plated, cast-iron piers and large windows for the first and second stories and Colusa sandstone above, including the cornice and the balustrade parapet. The walls on the other three sides are of common brick with sandstone ornamentation. The building was of steel frame construction. Above the third floor, the wall columns were omitted and the walls were used as bearing walls.

The fire-proof floors in the three lower stories consisted of

4″ x 8″ x 15″ single cell hollow tile blocks laid on the 8″ side in the form of a segmental arch. Raised hollow tile skewbacks of special form were adjacent to the beams and protected the soffits by a slab, which fitted into dovetail projections on the skewbacks at each side.

The girders were protected by special blocks with soffit slabs, similarly to the beams. The columns were protected by 2″ hollow tile blocks. Over the top of the segmental hollow tile arches was laid 4″ of cinder concrete fill. Over this were placed the wood sleepers with cinder concrete filling between them, on which was laid the wood floor finish. The tie rods were generally placed 2″ from the top flanges of the beams and were concealed within the floor construction.

Underneath all the floors, except the first, was erected a flat wire lath and plastered ceiling. This ceiling was supported by 1¼″ x 3/16″ furring bars at 16″ centres, which were fastened to the beams by a poorly designed L clip of ½″ x ⅛″ steel. The wire lathing was No. 20, 2½ mesh, painted, with ¼″ round steel rods wired to it at intervals of 7½″.

The partitions enclosing stairways were of 3″ and 4″ hollow tile blocks. The mezzanine floor in the first story consisted of 9″ flat end construction arch blocks with side construction skewbacks.

Effects of the Fire and the Earthquake:

The Market Street front of the building is but slightly damaged, but it has broken away from the side walls and is temporarily tied to prevent it from falling into the street. The entire front is out of plumb and leans to the north 7″. The only damage of any consequence is to the balustrade parapet, one-third of which is missing in the middle portion. The east and west walls of common brick are cracked at numerous places and damaged, and are partly down. The entire rear wall is down to the fourth floor level, having fallen outward.

The interior of this building is almost a total wreck and is more extensively damaged than any other fire-proof building in the burned district. Practically nothing remains of the upper portion of the building above the third story. Only a few steel columns and badly distorted beams and girders project above this level.

The sides of the large central light court failed in many places, the structural steel members and sections of the wire lath and plastered ceilings being suspended in numerous places from portions of the sides that remain standing. In addition to the wreck of the large central light court, sections of the following size and location have collapsed from the roof to the basement:

30′ x 60′ west of the centre.
24′ x 60′ in the southeast corner.
30′ x 40′ east of the centre.
30′ x 30′ northeast of the centre.
45′ x 60′ in the northeast corner.
30′ x 60′ in the northwest corner.

These collapsed sections comprise about one-third of the entire floor area of the building.

There are a large number of columns that have buckled from the heat in the basement story adjacent to the collapsed sections. There are also numerous buckled and deflected columns in different portions of the building that show evidences of having been heated to a red heat after the hollow tile column protection had failed. In some cases these columns have doubled over on themselves and present very curious, though interesting, studies of the manner in which steel fails when highly heated. It is noticeable that wherever the steel work is considerably warped, the hollow tile blocks have fallen out. The light steel, wire lath and plaster ceiling construction, with the plaster still adhering to it, is lying about over the floors in all manner of grotesque shapes and clinging in sheets to portions of the steel framing in places.

The cast-iron stairway, elevator shafts, mechanical and power plant and all the fixtures and appliances are totally wrecked.

Comments:

The building being used as a department store, and being the receptacle of large quantities of inflammable goods, no doubt caused a fire of considerable duration and intensity.

This building was, no doubt, considerably damaged by the earthquake, but by far the greatest damage was caused by the fire. A careful examination and study of the present condition of the steel work and other facts and evidence leads to the

PARROTT BUILDING. First Story. Looking toward the central light court from the east. Showing wreckage of steel, hollow tile floor arches, partitions and column covering, and wire lath and plaster ceilings, much of which fell into the open space of the light court. Note the badly deflected basement column in the lower left-hand corner.

PARROTT BUILDING. First Story, looking toward the central light court from the south. Showing vast amount of wreckage and damage to the hollow tile floors, partitions, and column protection and the wire lath and plaster ceilings. Two columns buckled by the heat are in the right and left foreground.

PARROTT BUILDING. First Story. Showing a buckled column in the centre foreground and the great damage to the hollow tile floors, column covering and partitions, caused by column failure. The flat wire lath ceiling of the third story with plaster adhering to it, is hanging down at upper right hand. A deflected column is at the extreme left.

PARROTT BUILDING. Third Story. Showing the total wreck and disappearance of the upper portion of the building, which was of wood construction supported by steel framing. Three badly buckled columns are in the foreground. The wall columns of the steel frame were omitted above the third story, and the walls above this level were used as bearing walls. When the fire consumed the wood floors of the upper stories and wrecked the steel framing, large portions of the side and rear walls above the third story level were overthrown. Note the badly distorted remnants of the steel work projecting above this story.

CROCKER BUILDING. Market, Post and Montgomery Streets. The façades are of granite for the first and second stories and buff terra cotta above. With the exception of the second-story window heads on the Post Street side, which are slightly spalled, the façades are comparatively little injured by the fire; but the earthquake caused considerable damage to the walls in the upper stories. The roof, of wood construction, was consumed, causing the collapse of the light steel framing supporting it, which fell to the eleventh floor and broke down some of the hollow tile floor arches. A column on the ninth floor buckled on account of the failure of the hollow tile protection. The soffits of the hollow tile floor arches are off over considerable areas, exposing the cellular spaces. Some of the arches were broken out by falling safes. The hollow tile partitions are badly wrecked throughout the building. The hollow tile column protection and exterior wall furring are greatly damaged, and have fallen away in many places.

conclusion that most of the collapsed sections in this building were caused by column failures.

The column protection was of hollow tile blocks only 2″ in thickness, laid in mortar of poor quality and in a rather indifferent manner. It is probable that had an efficient column protection been provided, the enormous damage to the interior would have been largely prevented. The difference in cost between a first-class column protection and the one that was employed would probably have been less than one-half of 1 per cent. of the original cost of the building.

Crocker Building.

Market, Post and Montgomery Streets.

A. Page Brown, Architect. Crocker Estate, Owner.

Details of Construction:

The Crocker Building is an eleven-story office building that was completed in 1892. The façades consist of granite for the first and second stories and buff pressed brick and terra cotta above. The metal frame is of steel throughout and well designed. The walls are self-supporting.

In the tenth story the walls have been stepped out so that the columns adjacent to them are within the wall lines. These columns are of Phœnix section, reinforced by channels. The walls are tied to the columns by U-shaped steel bands 2¼″ x 1¼″. The wall girders in this story are tied to the walls by ¾″ rod hooks over the lower flanges. The east angle of the building is braced by two heavy vertical trusses. Special steel construction also supports the second and third story floors by eye-bar suspenders at the east end of the building, so as to eliminate columns in the first story.

The fire-proof floors are of hard burned hollow tile flat arch blocks, 10″ in depth, the skewbacks supporting soffit tiles under the beams. The partitions and column protection are of 3″ hollow tile blocks, and the wall furring of 1½″ hollow tile blocks. The floors are finished in wood over wood sleepers and sleeper fill. The floor finish of the hallways is of marble tiles.

Effects of the Fire and the Earthquake:

The second-story window heads of the Post Street side are slightly spalled. The rest of the front is in good condition, except that there are a few small earthquake cracks in the upper part of the east angle. The Market Street front is also in good condition. The west brick wall is damaged by earthquake cracks near the top at the southwest corner of the northwest section.

The levels on the water table indicate that the northwest corner is about 1″ higher than the other three corners. The greatest observed variation of the walls from the plumb is at the southwest corner, where the west wall leans to the west about ⅝″. The chimney at the northerly corner of the light well is about 2″ out of plumb, leaning to the south.

In the ninth story, a column near the east end is badly deflected on account of the failure of the hollow tile protection. In the eleventh story, the 5⅛″ diameter wrought-iron pipes, of 7/32″ metal, supporting the light framing of the wood roof, failed in several places, causing the total wreck of the roof framing and much damage to the eleventh story floor. These light columns were simply wrapped with metal lath and plastered, the plaster being only about ⅝″ in thickness and in contact with the pipe.

The ornamental plaster work of the banking room in the first story is badly damaged. The main entrance hall is in fair condition. The vault in the first story and the safety deposit vaults in the basement are uninjured.

The floor arches are broken out in one case from the roof to the second floor, and in another case from the eighth floor to the basement by safes or other heavy bodies. In the third tier, two other floor spans failed. The rest of the floor construction is only in fair condition, there being numerous spots, from single blocks to 50 square feet in area, where the soffits of the tiles have failed, exposing the cellular spaces.

The hollow tile partitions are badly wrecked, having fallen down throughout the building. The exterior wall furring is off in many places and cracked and loose where it still adheres to the walls. The hollow tile column covering is greatly damaged and has fallen away in a number of places.

The elevator fronts and cast-iron stairways are damaged, but portions may be repaired.

CROCKER BUILDING. Second Story. Typical view showing damage to the hollow tile floor arches, column covering and partitions. The *débris* had been removed from the floor when the photograph was taken.

Comments:

This building was subjected to a normal fire only, there being no evidence of intense heat anywhere.

The building is damaged very little structurally, excepting in the top story where the light wrought-iron pipe columns failed, and in the ninth story where one of the steel columns buckled.

The weakness of hollow tile blocks and their failure to carry safes and other heavy objects was again demonstrated in this building. Inadequate protection of the light columns in the top story caused a great deal of damage, requiring the entire reconstruction of the roof and extensive repairs to the eleventh floor. The undesirability of a roof of wood construction over a building of this character is evident. The addition of the eleventh story was decided upon after the original plans had been completed, and it was not as skilfully planned as the rest of the building.

Chronicle Building.

Junction Kearny and Market Streets.

D. H. Burnham Co., Architects. M. H. De Young, Owner.

Details of Construction:

This is a nine-story building that was occupied by the San Francisco *Chronicle* and was completed in 1888. It is the oldest of the high buildings in the city, and was built with special reference to fire-resisting qualities, according to the best methods known at that time. The façades consist of brown sand-stone for the first story, pressed red brick for the second story and red brick with terra cotta ornamentation above. The metal frame consists of cast-iron columns with steel beams and girders. The walls are self-supporting.

The fire-proof floors consist of 9″ side construction, hard burned, hollow tile, single cell blocks. The soffits of the beams and girders are protected by a slab of tile anchored to the skew-backs. A 3″ hollow tile filling block is laid over the top of the arch blocks. Wood sleepers with a cinder concrete filling between them are laid over the filling blocks and the floors finished with wood flooring. The cast-iron columns are protected by 3″ hollow tile blocks. The partitions throughout are of 4″ hollow tile blocks. The roof was of wood construction, supported by steel beams.

Effects of the Fire and the Earthquake:

This building was subjected to a normal fire only. The sand-stone of the Kearny Street front at the first story is very badly spalled. The red brick of the second story, and in the upper portions of the building, is practically uninjured, but some of the terra cotta ornamentation is damaged. The Market Street front is apparently in good condition, it being very little spalled and having no earthquake cracks.

The levels at the water table show that the foundations remain practically level. Observations on the southerly front show that it leans about 4″ to the south at the southwest corner. The Market Street front leans to the south about ¾″ at the southeast corner.

The interior of this building on the Kearny Street side, comprising an area of about 30 x 40 ft., has collapsed from the roof to the basement, the distorted steel beams and girders and the *débris* of the hollow tile floors completely filling the basement to the first story level. The parapet wall and cornice which are missing were probably pulled down when this portion of the building collapsed.

The manner in which the steel work was broken down presents some interesting features. In several instances where the floors of bay windows were supported by double beams projecting beyond the walls the double beams have broken at the separator holes in line with the inside surface of the wall. In the top story, a cast-iron wall column was broken about midway of the height of the story, the broken top with the beam and girder connections having dropped down so that the beams which supported the floor above now rest on the top of the broken column. The steel frame in the portion of the building that did not collapse is in fair condition.

The hollow tile column protection was badly damaged and fell away in numerous places, but served its purpose sufficiently well to prevent any damage to the columns. The hollow tile floor arches are considerably injured, there being spots from a few feet to 50 square feet in area, where the soffits are missing and

CHRONICLE BUILDING AND ANNEX. Junction Kearny and Market Streets. The original building is on the right. The brown stone of the first story is badly damaged, but the pressed red brick above is uninjured. Some of the terra cotta ornamentation around the brickwork is spalled. The burning of the wood roof no doubt started the precipitation of 19 linotype machines in the top story on the Kearny Street side, which fell to the basement, carrying with them successive tiers of steel framing and hollow tile arches underneath. In the rest of the building, the hollow tile arches are damaged in many places; the 4″ hollow tile partitions are badly wrecked; and the 3″ hollow tile column protection is damaged, and has fallen away in spots.

The façade of the new annex, consisting of gray sand-stone and terra cotta for the first story and pressed red brick and terra cotta above, sustained little fire damage, but is considerably injured by characteristic X earthquake cracks from the seventh to the thirteenth stories. The annex was in the course of construction, and was subjected to a moderate fire only from the combustion of scaffolding lumber, wood trim, etc. The soffits of a number of the heavy 16″ flat hollow tile floor arch blocks were spalled off, and the hollow tile partitions and column covering were damaged so that considerable sections will require rebuilding. The steel frame is uninjured, excepting one column between the two buildings, which was unprotected at the time of the fire.

CHRONICLE BUILDING. Showing the interior on the Kearny Street side, which collapsed from the roof, the wreckage filling the basement to the ground-floor level. The columns are of cast iron, with steel framing supporting the floors. Two double beams supporting bay window projections on the left-hand side have broken off at the separator holes and remain hanging in a vertical position. The fire-proof floors were built of the old-style single cell 9″ hollow tile blocks. A wood roof and 19 linotype machines in the top story are responsible for this damage.

the cellular spaces exposed. The 4″ hollow tile partitions are badly wrecked, most of the blocks having fallen down.

Comments:

The collapse of the Kearny Street side of this building is supposed to have been caused by nineteen linotype machines which were located in the top story. The burning of the wood roof no doubt contributed also to the damage by increasing the duration and intensity of the fire in this story and by falling *débris*.

The southerly front adjacent to the collapsed section is considerably out of plumb, and is also damaged on the inside by the collapse of the steel work. This wall will probably require reconstruction, as well as the collapsed section in the interior. The remaining portions of the building can be repaired.

Chronicle Building Annex.

Junction Kearny and Market Streets.

D. H. Burnham & Co., Architects. M. H. De Young, Owner.

Details of Construction:

This is a seventeen story addition to the *Chronicle* Building and was in the course of construction at the time of the fire. The façade consists of sand-stone and terra cotta for the first and second stories, and red brick and terra cotta above. The metal frame is of the steel skeleton type, the walls being curtain walls.

The fire-proof floors consist of heavy hollow tile end construction, flat arch blocks 16″ in depth, the shells and webs being 7/8″ in thickness. The skewbacks support the soffit protection under the beams. The partitions are of 4″ hollow tile blocks and the column covering of 3″ hollow tile blocks.

Effects of the Fire and the Earthquake:

There was very little fire in this building, the combustible contents consisting of scaffolding, wood trim, etc. The damage to the building was wrought largely by the earthquake. One pier between windows at the third story, and the two middle piers from the seventh to the thirteenth stories, are cracked and badly racked by the earthquake. A section of the face brick has fallen away from one of the piers at the twelfth story level. The north wall of brick is in good condition. The east wall shows earthquake cracks in the upper portion.

The levels on the water table show that the southeast corner is about 7/8″ lower than the other corners of the building. The greatest observed variation of the walls from the plumb is at the southeast corner adjacent to the old *Chronicle* Building, which leans 1/2″ to the west.

One unprotected column between the old and the new buildings is deflected, and the elevator framing is distorted by the fire. In several stories, where scaffolding and wood trim were stored, the fire has damaged the floor arch blocks, exposing the cellular spaces. Some of the column covering and partitions has also been damaged from the same cause, and will have to be rebuilt.

Comments:

The steel frame of this building is uninjured. Sections of the walls will have to be rebuilt on account of earthquake damage. There is apparently a structural weakness at the eleventh and twelfth story levels, where the racking effect of the earthquake caused the greatest damage.

This building being in the course of construction and unfinished, the repairs will be comparatively small.

Spring Valley Building.

S. E. Cor. Geary and Stockton Streets.

Clinton Day, Architect. Spring Valley Water Co., Owner.

Details of Construction:

This is a six-story store and office building. The façades consist of gray granite and cast iron for the first and second stories and pressed terra cotta brick, with terra cotta ornamentation above, including the cornice. The building has a steel skeleton frame. The light court walls are built of 4″ hollow tile blocks, lined on the inside by 3″ blocks, each bay between wall girders and columns being braced by light diagonal members from the intersections.

The fire-proof floors of the lower stories consist of 10″ hollow tile end construction, flat arch blocks, with 1″ tile slabs anchored to the skewbacks for soffit protection. Above the third

SPRING VALLEY BUILDING. Basement Story. Showing the typical damage in this story to the hollow tile floors and column protection. The openings through the ceilings show the total failure by fire of the floor arches at those points. At the extreme left is shown a portion of a large section of the building that collapsed. The hollow tile and plaster *débris* on the floor averages 8″ in depth.

SPRING VALLEY BUILDING. First Story from the northwest corner of the building looking south. Showing the failure of the soffits of the hollow tile floors and the soffit protection of the beams and girders. The column protection is only slightly damaged in this story.

floor level the fire-proof floors are of tile blocks, segmental in form, the spans between girders being 16 ft. The rise of the arch is about 8″ and the girders are tied together every 4 ft. by 1¼″ round tie rods. The tile blocks are 5″ x 8″ x 15″ in dimension and are laid with the 8″ side down, making an arch 5″ in thickness. The blocks have a vertical web, the shells being 1″ and the webs ¾″ in thickness. Under the segmental arches, at the soffits of the beams, is erected a wire lath and plaster flat ceiling.

The roof consists of 3″ hollow book tile, laid on tees spaced 18″ centre to centre. Underneath the roof is a suspended ceiling consisting of tee iron framing at 16″ centres, which supports 3″ rabetted hollow tile blocks. The roof framing is supported by 8″ I beam struts over the columns. The columns are protected by 2″ hollow tile blocks. The partitions are of 3″ hollow tile blocks.

The floor finish is of wood laid on wood sleepers with cinder concrete filling between the under side of the wood finish and the top of the floor blocks.

Effects of the Fire and the Earthquake:

The Geary Street front remains in good condition, there being no earthquake cracks and the cornice being only slightly spalled in spots on the east side at the second-story level. The Stockton Street front is also in good condition, excepting that there are slight earthquake cracks at the north and south corners at the second-floor level. The east brick wall is in good condition. The south brick wall has a vertical crack down the centre from the top to the fourth floor, and then diagonally to the ground near the Stockton Street front. The upper rear portion of the wall, back of the crack referred to, has bulged out as much as 4″.

The levels on the water table show that the foundations remain practically level. Observations on the front walls indicate that they are plumb.

In the southeast corner of the building, eight complete bays have collapsed and fallen from the roof to the basement. In the basement story, one column is buckled, the heat having bulged pipes within the hollow tile column covering and forced it off. In the second story, the second wall column from the street, on the east side, is deflected. In the fourth story, the wall columns on the east side are sprung out of line by the bulging wall.

In the southwest corner of the sixth story, the 8″ I beam struts were buckled by the heat, letting down the roof framing to the sixth floor, and destroying the hollow tile blocks of the roof and the hung ceiling. The failure of these struts, or of some of the members of the roof trusses, also probably caused the trusses in the southeast corner of the roof to fall, carrying everything down beneath them and wrecking that section of the building.

The diagonal vertical braces in the bays of the light court are badly bulged and distorted by the heat.

The hollow tile flat arch blocks in the lower stories are badly damaged. Almost the entire ceiling area in the basement is in bad condition, the soffits of the tiles having fallen away, exposing the cellular spaces. There are large areas in the first and second stories where the soffits of the blocks have similarly failed. In the upper stories, where wire ceilings were erected underneath the segmental tile arches, the ceilings remain in fair condition, and the arches above are apparently in good condition. In places where the ceilings have failed, the blocks are damaged.

Large sections of the hollow book tiles of the roof and hung ceiling under it are wrecked. The hollow tile partitions in the lower stories are in bad condition, most of the blocks having fallen down, and, where they are still standing, the partitions are weak and will have to be rebuilt. In the upper stories where the partitions are carried to the lath and plaster ceiling, they are generally in much better condition, the tile blocks over door openings remaining in position in many cases.

The hollow tile walls of the light court are greatly damaged and cracked, and many of the outside blocks and those of the inside lining have fallen away. The 2″ hollow tile column covering has failed in many places, and is badly damaged where it still remains in position.

The elevator fronts and cast-iron stairway, with marble treads, are damaged but can be repaired.

Comments:

The fire protection afforded by a wire lath and plaster ceiling

is clearly shown by the excellent condition of the hollow tile blocks above it. In other parts of the building, where the wire lath ceiling was omitted, the blocks are badly damaged. The advantage of carrying the hollow tile partitions only to the wire lath and plaster ceiling, instead of to the under side of the fire-proof arches, is also clearly shown. The 2″ hollow tile protection of the columns was not sufficient to protect them against buckling, and the failure of this protection is no doubt responsible for the entire damage to the southeast corner of the building.

The repairs to the exterior of the building will be comparatively light. Many of the floor arches of the three lower tiers will require renewal or extensive repairs. The collapsed portion will require entire reconstruction.

Mills Building.

N. E. Cor. Sutter and Montgomery Streets.

D. H. Burnham & Co., Architects. D. O. Mills, Owner.

Details of Construction:

The Mills Building is an eleven-story office building. The façades consist of white marble for the first two stories and buff terra cotta pressed brick, with terra cotta ornamentation, above. The cornice is also of terra cotta. The metal frame is of steel, the walls being self-supporting.

The fire-proof floors consist of hollow tile end construction, flat arch blocks, 12″ in depth. The spans between beams are 7 ft. Under the centre light court the floor arches are of brick, segmental in form.

The partitions throughout are of 4″ hollow tile blocks. The column protection consists of 4″ blocks, where the lines of the partitions are adjacent to the columns, and of 2″ hollow tile blocks on the other two sides and elsewhere where there are no partitions.

The soffit protection of the beams and girders consists of tile slabs anchored to the skewbacks, and in the case of the double girders held in place by metal clips. The light court is faced with cream brick and terra cotta ornaments.

The floor finish was of wood laid on wood sleepers and concrete fill from the top of the hollow tile arch blocks to the under side of the floor finish. The hall floors are finished in marble.

Effects of the Fire and the Earthquake:

The marble on the south side of the Sutter Street front is badly damaged and will require entire renewal. The north side is damaged less and may be repaired. There are slight earthquake cracks along the third-story level. The marble is also badly spalled around the window openings on the Montgomery Street front. At the third story, the terra cotta is badly cracked by the earthquake, but has sustained very little damage above. The north and east walls have also been considerably damaged by the earthquake. The terra cotta ornamental work of the light court is slightly spalled and cracked throughout, but the face brick is in good condition.

The levels on the water table indicate that the front half of the foundations of the building remain level. It was impossible to find corresponding points in the rear of the building to make comparisons. The south front of the building is considerably out of plumb. At the southwest corner it leans to the south about 4″. The Montgomery Street front remains plumb.

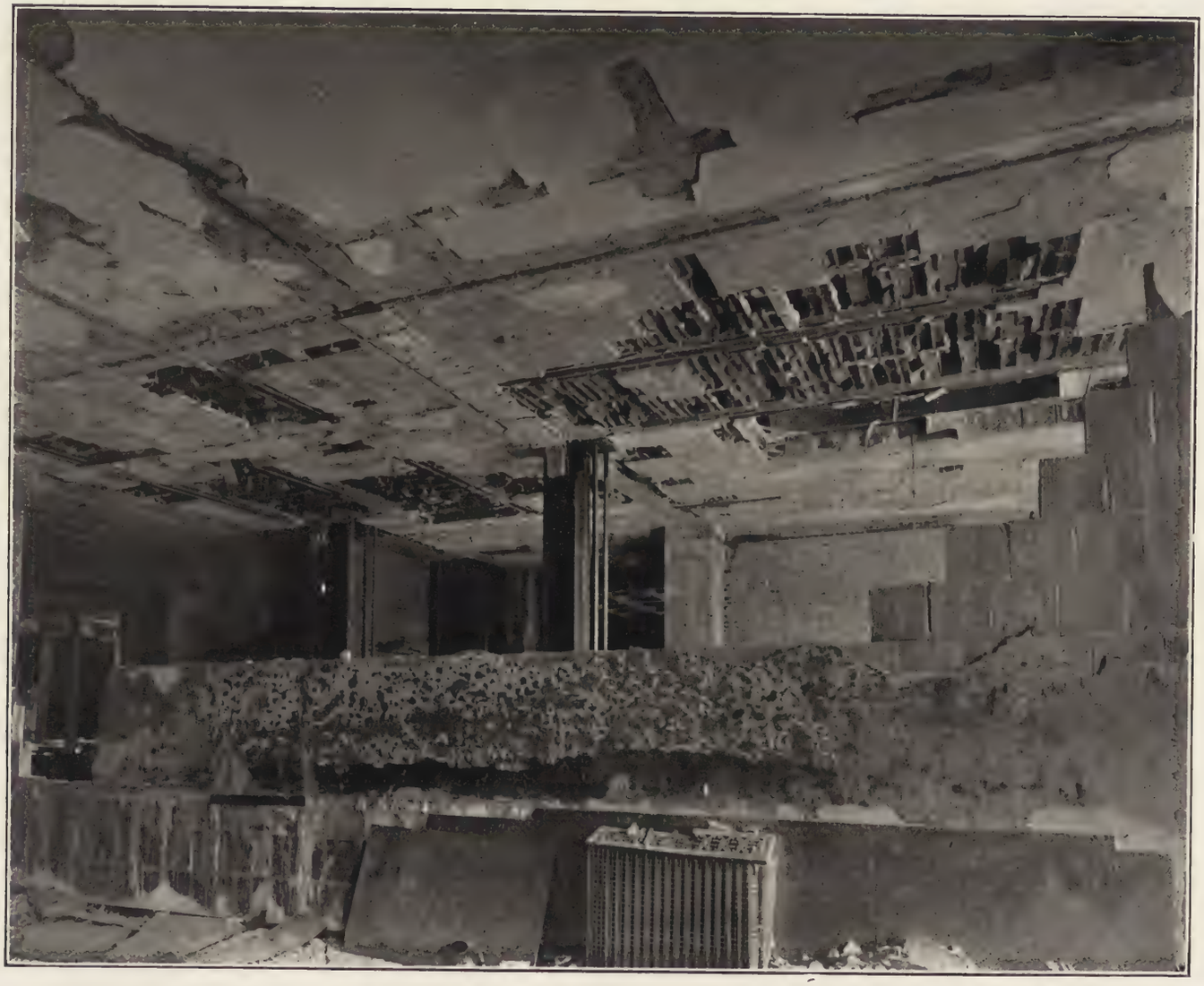
On account of the failure of the hollow tile column protection, the steel frame of this building has suffered considerably. In the basement there are three main and one secondary columns that have buckled. The steel members supporting the mullions between windows facing the light court are badly buckled in many cases.

The hollow tile floors have been considerably damaged throughout. At numerous places there are large areas where the soffit members of the floor blocks have failed and fallen away, exposing the cellular spaces. Several safes have fallen from the upper stories and broken through successive floors to the basement.

The hollow tile partitions are completely wrecked in many places, and where still standing they are so weak that they will have to be rebuilt. The column protection, in many cases being a part of the partition, was badly disrupted when the partitions failed. Bulging pipes that followed the lines of the columns also contributed largely to the failure of the column protection.

MILLS BUILDING. Basement Story. Showing the failure of the hollow tile column protection and a buckled column; also openings in the floor spans adjoining the buckled column. The hollow tile floor arches fell out when the steel beams supported by the buckled column settled. The piping near the ceiling line adjacent to the column was probably, in part, responsible for the beginning of this damage.

MILLS BUILDING. Basement Story. Showing the damage to the hollow tile protection of the columns. The deflected columns were caused by the total failure of the protection.



MILLS BUILDING. First Story. Showing the failure of the hollow tile column protection, and the damage to the hollow tile floors. A large proportion of the partition blocks in this building are down.

MILLS BUILDING. First Story. Showing the damage to the hollow tile floor arches, column covering, and partitions. The vault of the Scandinavian Bank, at the right, is uninjured. Note the separate shaft for pipes outside of the column protection, at the left.

MILLS BUILDING. Second Story. Showing the damage caused by a safe falling from one of the upper stories. The safe in the pile of *débris* rests on a beam in line with the column.

MILLS BUILDING. Second Story. Typical view showing the damage to the hollow tile floors and partitions. The soffit protection of the girders supported by the metal clips remains in place.

MILLS BUILDING. Second Floor. Typical view showing the damage to the floor arches, column protection and partitions. Note the metal clips holding the soffit protection of the double girders in place. Much damage was caused by the partition blocks falling into the elevator and stairway wells.

MILLS BUILDING. Fourth Story. Looking east toward the central light court. Showing typical damage to the hollow tile floors, partitions and column covering in this building. The bulging of the pipes within the column covering doubtless caused much of the damage to the protection.

The elevator fronts, and cast-iron stairways with marble treads, are badly damaged. The mechanical plant in the basement is slightly injured, and can be repaired.

Comments:

The marble work, and some of the terra cotta, will require renewal. In replacing the buckled columns, it may be necessary to remove portions of the walls in order to inspect the connections. For this reason, and also on account of the earthquake damage, it may be necessary to reconstruct large sections of these walls.

The hollow tile floors will require extensive repairs, and the hollow tile partitions and column covering will have to be entirely rebuilt. Some of this material has been damaged by the heat so that it can be crumbled by the fingers. Blocks that are whole and appear to be in good condition, where they have been subjected to considerable heat, have lost their strength and will not be serviceable for new work.

This building furnishes another example of the weakness of hollow tile blocks to sustain safes. The extensive damage to the soffits of the hollow tile floor arches by the heat of a normal fire only should be noted. The failure of the soffit surfaces of the hollow tile blocks was no doubt caused largely by unequal expansion. Blocks with large cellular spaces and comparatively thin shells and webs are poorly adapted to resist the abnormal strains caused by unequal heating.

The bad practice of carrying pipes within the column protection was also followed in this building. A great deal of the buckling and destruction of the upright steel supports of the window mullions would have been avoided had provision been made for the expansion of these members.

County Jail.

North Side of Broadway, between Kearny and Montgomery Streets.

Details of Construction:

The County Jail is an old building of massive construction. The front portion is three stories in height, the rear portion being devoted to cells, which are arranged in two tiers. The front wall has an ornamental cementine finish. The floors at the street level rest directly on the ground. All exterior walls are of heavy masonry around the cells, and of brick in other locations, the partitions in the front portion of the building consisting of brick walls. The small sections of flooring above the ground level in the front of the building consist of segmental brick arches, groined in some cases.

The floor finish is of cement at the ground level and of wood on sleepers and sleeper fill in the upper stories and cells. The roof was constructed of wood.

Effects of the Fire and the Earthquake:

The wood roof has disappeared. A mass of brick-work fell from above and broke down several sections of the brick floor arches in the front portion of the building, which apparently is the only structural damage to the building.

The small window openings and the heavy walls of the cells prevented the fire from doing any considerable damage in this portion of the building, the wood floor finish remaining in many places.

Comments:

This building can be repaired and restored without difficulty.

Stock House and Brew House, John Wieland Brewery.

Second Street, between Howard and Folsom Streets.

Mr. Winterhalter, Architect. John Wieland Brewing Co., Owner.

STOCK HOUSE.

Details of Construction:

The Stock House is a three-story and basement building of heavy construction. All the walls are of brick and are bearing walls, the front having a cementine finish to the second floor level.

The floor loads are supported by cast-iron columns and steel framing. The roof was of wood construction. The columns and the soffits of the beams and girders are unprotected.

The fire-proof floors consist of 8″ double rowlock brick arches, the spans between the beams averaging about 4 feet. The floor finish is of cement, 2″ thick, laid on a concrete filling over the floor arches.

YOUNG (OR SELLER) BUILDING. Southwest Corner Spear and Market Streets. The granite of the first story is very badly spalled, and will require complete renewal. The terra cotta brick and terra cotta ornamentation above is much less injured, but is spalled and cracked in many places. The foundation on the east side has settled, and the east and west walls are out of plumb about 5″. The columns were protected by expanded metal lath and plaster and remain in good condition. The steel beams and girders of the second floor are protected on the underside by a flat ceiling of expanded metal lath and plaster, and are in good condition. In the upper stories, where the soffits are exposed, the steel framing is badly deflected. The concrete floors are of the expanded metal suspender type of cinder concrete, and are in fair condition in the two lower tiers, but in the upper tiers the floor construction is badly sagged on account of the suspender bands being unprotected. The hollow tile partitions inclosing the stairway in the first story and the toilet room in the second story are down. The hollow tile wall furring is badly damaged, and is off in many places. Note the good condition of the soffits of the window openings, which were protected by terra cotta anchored into place by ¼″ round steel rods.

Effects of the Fire and the Earthquake:

The fire entered the building through unprotected window openings and consumed the wooden roof. Fifty-three huge casks, 9 ft. in diameter and 16 ft. high, were burned in the top story, the steel hoops lying on the concrete floor where the casks had originally stood.

The fire consumed the wood frames and sash of several window openings in the lower stories, but did no further damage. Part of the parapet wall of the roof fell over, but the walls are very little damaged by the earthquake. The metal frame and the concrete floors in this building are uninjured. A fire-proof roof will probably be substituted when the building is restored.

BREW HOUSE.

The Brew House adjoins the Stock House and is a two-story structure. The floor at the ground level is fire-proof, supported by cast-iron columns and steel beams. The second floor and roof were of wood construction, also supported by cast-iron columns. The finish of the basement and ground floors was in cement.

The basement story was filled with huge casks. A cooper shop was located in the rear of the first story, a large quantity of oak staves and casks being stored in this portion of the building.

The fire consumed the top story and the roof, the falling *débris* doing no damage whatever to the concrete floor at the ground level. The intense heat generated in the cooper shop was sufficient to burn off two cast-iron columns, the sections of the metal at the severed parts being about ¼″ in thickness and of irregular contour, the edges being smooth and showing that there was no fracture.

MALT HOUSE.

Located on the block bounded by Chestnut, Frisco, Powell and Mission Streets.

This is a five-story building and is all that remains of the brewery of the Bauer-Schweitzer Hop and Malt Co. It is approximately 50 ft. x 70 ft. in plan. The walls are of brick, 21″ in thickness, and are well tied together by steel rods.

The fire-proof floors consist of 4″ rowlock brick arches between steel beams, at 4 ft. centres, supported by steel girders and unprotected cast-iron columns. The floor finish is of cement.

There was little in the Malt House that was combustible, and it had very few window and door openings. The interior is in good condition, having sustained practically no fire damage. The rest of the brewery buildings were of ordinary construction, with wood floors, and were totally destroyed.

YOUNG OR SELLER BUILDING.

S. W. Cor. Spear and Market Streets.

HERMAN BARTH, Architect. W. W. YOUNG, Owner.

Details of Construction:

The Young Building is a five-story and basement structure which was used as a store and loft building. The façades consist of gray granite and cast iron to the second floor level, buff terra cotta pressed brick above, and a terra cotta cornice. The walls are self-supporting and are built upon pile foundations.

The columns and girders are of steel; the fire-proof floors are of the expanded metal "suspender" type, the spans between the girders being 15′. The floor slab is of cinder concrete about 4″ thick with 3″ mesh No. 16 expanded metal imbedded in it. Under the floor slab at 4′ centres and at right angles to the girders are concrete ribs supported on the under side by 5″ by ⅜″ steel bands or suspenders hooked over the top flanges of the girders, and curving downward so that the concrete rib and suspender under it project about 8″ below the concrete slab midway between the girders. The usual wood floor finish (consisting of 2″ sleepers at 16″ centres with cinder concrete filling between them, and wood flooring nailed to the sleepers) was laid over the concrete floors for a wearing surface. The inside surface of the exterior walls was covered with 1½″ hollow tile wall furring.

The columns are protected by expanded metal lath and three coats of plaster. The soffits of the girders, beams and suspender bands are protected in the first story by a flat ceiling of expanded metal lath and plaster, but in the upper stories they are exposed.

YOUNG BUILDING. First Story. Showing the damage to the expanded metal lath and plaster column protection, and the earthquake cracks in the flat expanded metal lath and plaster ceiling. The pipes in the wall chases have bulged and forced off the hollow tile wall furring in spots.

YOUNG BUILDING. Second Story. Showing the condition of the under side of the suspender system of the expanded metal floors. One floor span is broken down by sheet iron which fell through from the fourth story. This floor construction, on account of the expansion of the exposed suspender band, deflected badly throughout the building, even where there was little or no load resting on it. There is an earthquake crack in the rear wall in the centre. The hollow tile partition around the toilet-room in the rear is badly wrecked. The crack around the expanded metal lath and plaster column covering, about five feet from the floor, occurs throughout the building, and probably marks the height of the wood trim, or the sections of the completed plaster work during the construction of the building.

Effects of the Fire and the Earthquake:

The granite of both the Market Street and Spear Street sides is very badly spalled and scaled by the fire and cannot be repaired. The terra cotta brick and cornice is much less damaged by the fire, but the bond between the face brick and backing has been broken in many places by the earthquake. The N. E. and S. W. corners of the building are badly racked and shattered. The west brick wall has a vertical crack in the middle. The east and west walls are out of plumb and lean to the east 5½″ and 5″ respectively. Levels on the water table show that the N. E. and S. W. corners are 3″ and 6″ lower respectively than the N. W. corner. These facts would indicate that the foundations had moved sufficiently to tilt the entire building to the east. From marks on the curb of the sidewalk, it is also apparent that the surface of the ground settled considerably around the N. E. corner.

The entire building was occupied by a hardware concern. The stock being composed largely of metal goods, the fuel for the fire consisted principally of the wood finish and trim, the packages, counters, shelving, etc. The intensity and duration of the fire was therefore probably not much greater than in the case of an ordinary office building or hotel.

The steel columns are in excellent condition, the lath and plaster protection remaining intact except in a few spots where the plaster is off. A number of the girders and beams having their soffits exposed, above the second floor, are permanently sagged. One 12″ beam in the third story is sagged at least 12″ between the columns. Two wall channels at the roof level, near the N. E. corner, were buckled upward 5″ between the columns by strains induced by the deflecting concrete roof slab. Two tie beams in the roof tier near the north end are also buckled upward.

Although the cinder concrete was originally of inferior quality, the first and second story floors are in fair condition. The wall furring is off in spots, and badly cracked and loose in many places. The hollow tile blocks enclosing the stairway on the first floor and the toilet room in the second story are down. The metal lath and plaster partition around the freight elevator is in bad condition, but still standing. There are cracks in the north wall at the lintel corners in the second story. In the third and fourth floors, three panels between suspender ribs failed from an overload of sheet iron, breaking the suspender bands where they were hooked over the top flange of the girder. About 50 per cent. of the third and fourth floors and the roof is sagged from 3″ to 12″ between girders, on account of the poor quality of the concrete and the suspender bands being exposed on the under side. The roof tier supported a temporary tin roof on a wood frame. The wood-work burned out, letting the tin roof down on the concrete slab. Although the concrete roof tier supported only the light temporary roof, it deflected almost as much as the third and fourth floors. The east parapet wall (9′ high) is cracked loose from both the north and the south walls. One-half of the central part of the west parapet wall failed; the south end falling inward and the north end outward.

The cast-iron elevator fronts and stairways are down in most places and badly distorted where still in position. The pipes bulged and buckled in the wall chases, forcing off the hollow tile covering.

The steel members supporting the masonry over the large window heads (openings 8 ft. wide) were well protected by terra cotta fastened by rod anchors.

Comments:

The location of the building was particularly unfavorable. It was built on "made" or filled in ground, which since the earthquake has been proved to be exceedingly unreliable for foundations. Had this fact been known when the building was designed, the foundations would have received special attention, in which case the walls would probably have been very little damaged.

It will not be economical to repair or restore this building. The foundations may be utilized for a building of the same or less height, and some of the steel, terra cotta and face brick can probably be utilized in rebuilding. This type of concrete floors is poorly adapted to withstand fire and should be discontinued in fire-proof buildings. It is besides more expensive than other and better types of fire-proof flooring now furnished by the same company.

BUCKLEY BUILDING. This was a Class B building with metal frame and wood floors, excepting a small section in the rear corner of the building, which contained Roebling concrete floors. The brick walls, steel framing, and other *débris*, from the upper parts of the building, fell on this section of flooring, and elsewhere in the basement, to a depth of five feet. At the time the photograph was taken, workmen had cleared away a large portion of the *débris* resting on the concrete floor, which can now be clearly seen in the illustration. Note the wire lath and plaster wall furring adhering to the remaining walls.

Buckley Building.

S. E. Cor. Spear and Market Streets.

Thomas J. Welsh, Architect. Chris Buckley, Owner.

Details of Construction:

This was a "Class B" building with brick walls, cast-iron columns and wood floors. In one corner, used as a kitchen for a restaurant, was a small section of Roebling fire-proof flooring of the System B or flat slab type. In the concrete is imbedded a light steel framework of 2″ x ⅛″ steel bars, set on edge at 16′ centres with a ¼ turn at both ends where the bars are hooked over the steel beams. Separators of ½″ x ⅛″ steel are hooked over the bars at right angles to brace them.

Effects of the Fire and the Earthquake:

The entire building was wrecked by the fire; the walls, beams, fixtures and other *débris* from the upper stories falling into the basement, excepting in the corner where the fire-proof floors are located. There the floors carry this enormous load of *débris*, averaging five feet in depth, having, besides, successfully withstood the impact of the falling material.

Scott Building.

S. W. Cor. Fremont and Mission Streets.

Albert Pissis, Architect. Mrs. G. W. Gibbs, Owner.

Details of Construction:

The Scott Building is a five-story store and loft building that was occupied by various machinery concerns in the first and second stories and by printing and lithographing concerns in the top stories. The façades consist of Colusa sand-stone. The exterior walls are bearing walls. The floors are supported by cast-iron columns and steel girders and beams. The floors are of the expanded metal, segmental arch type of cinder concrete, the spans being about 5′ 3″ between beams. The partitions in the lower stories are of brick and of the 2″ solid expanded metal lath and plaster type, and in the upper stories of plaster on herring-bone lath applied to wood studs. The columns are unprotected. The girder and beam soffits are covered with expanded metal lath and plaster. The floors were finished in wood laid on wood sleepers and concrete sleeper fill. The hallway floors have an incombustible finish.

Effects of the Fire and the Earthquake:

The cornice and fifth story walls of both the Fremont and the Mission Street sides fell into the streets. The entire Mission Street front is badly spalled by the fire. The Fremont Street front is not so much spalled, but is badly cracked by the earthquake. The sidewalks along both fronts of the building were broken down by the falling of the fifth-story walls. The upper part of the S. E. L extension of the building is completely wrecked, the second and third stories of the extension being filled with the *débris* from the upper stories. The wall moved out so that the N. W. corner arch fell out, carrying a wall channel with it and breaking down successive floors to the second story. The S. W. corner of the building is badly racked and cracked by the earthquake. The N. E. and S. E. corners at the fifth-floor level are cracked and the floor arches fractured. The concrete roof was supported on light steel framing. The columns being of small section and unprotected, failed, causing the entire roof to fall to the tier below and breaking the roof concrete into small pieces. The cast-iron stairway and the elevator fronts are badly damaged.

Comments:

The concrete floors in the portion of the building still standing are in good condition. On account of the fire being of short duration and not intensely hot, the columns and steel are also in good condition.

This building will have to be largely or wholly rebuilt.

Crocker Estate Building.

S. E. Cor. Mission and First Streets.

Bliss & Faville, Architects. Crocker Estate, Owner.

Details of Construction:

This building was divided by brick walls into 50 sections, three fronting on Mission Street and one on First Street, and was originally five stories in height. The façades consisted of terra cotta for the first story and buff terra cotta pressed brick

SCOTT BUILDING. Second Story. Typical view showing the condition of the expanded metal concrete floors and the soffit protection of the girders and beams. The stairway well was not enclosed and the cast-iron columns were unprotected.

SCOTT BUILDING. Showing the ruins of the roof. The columns supporting the roof were of light section, and unprotected. The burning of the stock and furniture of a printing establishment, occupying the story directly under the roof, heated the columns sufficiently to cause their failure, the entire roof falling to the floor below and breaking the roof concrete into small fragments.

above. The rear and side exterior walls were of brick. All walls were bearing walls. The floors were supported by cast-iron columns and steel girders and beams.

The fire-proof floors were of cinder concrete, of the expanded metal flat arch type, the spans between beams being about 5′. The columns were unprotected and the soffits of the beams were lathed with expanded metal and plastered. The floor finish was of wood laid over sleepers and sleeper fill.

Effects of the Fire and the Earthquake:

The N. E. 50 ft. section fronting on Mission Street is totally wrecked. The interior of the middle section collapsed and fell into the basement. In the S. W. corner section fronting on First Street, the two upper stories collapsed and fell on the third floor. A portion of the south wall of this section fell outward. A portion of the top story and the cornice of both fronts of the building fell out and broke down the sidewalks. The levels on the water table show that the N. W. corner and the N. E. corner are ½″ and 1½″ lower, respectively, than the S. E. corner of the building. The north face fronting on Mission Street is badly out of plumb and bulged in the centre leaning to the north. The N. W. corner leans 1″ to the north and 3″ to the west. The S. W. corner is tilted 5″ to the N. E.

Comments:

The falling of the upper parts of the front walls and the cornice was probably caused by the earthquake. The collapse of the interiors may have been caused by the earthquake or by the fire, but more probably by the latter. The columns being exposed to the flames, would soon reach a temperature of 1300° to 1400° Fahr., at which temperature they become weak, and by bending or buckling would settle and pull down the entire framework around and above them. The exact portion of the destruction that was wrought by the fire can only be determined by a careful study of the ruins when the *débris* is being removed.

The concrete floors, where not destroyed in the collapsed portion of the building, are in good condition, and the columns and steel framing supporting them are also in fair condition.

This building will have to be rebuilt; the foundations only can be utilized in reconstruction.

Johnson Co. Building.

N. W. Cor. Minna and First Streets.

Albert Farr, Architect. J. C. Johnson Co., Owner.

Details of Construction:

This was a five-story structure, and was occupied and used by the owners as a store for harness and leather goods. The façades consisted of buff terra cotta pressed brick.

The walls are self-supporting. The columns are of cast iron, spaced about 16½′ centres, and are unprotected. The steel girders are set the north and south way in the building and have the soffits exposed. The floors between girders are of the reinforced concrete type, the floor slab of stone concrete, 4″ thick, being supported by three reinforced concrete beams about 5′ centre to centre in each bay. The floor slab is generally reinforced by ¼″ wire strands of seven wires each, spaced 16″ apart in the direction parallel with the reinforced beams and 8″ apart crosswise with the beams. In some cases heavy twisted strands, heavy wire, rods, etc., are used. The reinforced beams are about 12″ deep, and 1″ diameter round rods are imbedded in them an inch from the under side, where the beams are 5″ in width. The rods are threaded at the ends and anchored to the girders through holes punched in the webs. The floors were finished in wood, and the cinder sleeper fill 2½″ thick is reinforced at the under side with No. 16 hexagonal mesh poultry netting.

Effects of the Fire and the Earthquake:

The whole upper portion of the walls above the fourth floor level fell inward. The First Street side, the N. W. L extension and two bays in the middle portion of the building have collapsed and fallen into the basement, a number of beams, girders, rods, etc., in a tangled mass, hanging to the sides of the portions yet standing. Those portions of the fronts that remain standing are in bad condition. There is a decided break in the masonry at the S. E. corner at the second floor level. The Minna Street front is out of plumb 3½″ at the S. E. corner and 1½″ at the S. W. corner, leaning south. The N. E. corner leans north about 1″. The levels on the water table show that the foundations remain practically level. In the basement

JOHNSON & CO.'S BUILDING. First Story. Showing *débris* in the front of the building which collapsed from the roof to the basement. The columns were unprotected and reinforced concrete beams supported the floor slab between the girders.

JOHNSON & COMPANY'S BUILDING. Basement Story. Showing the failure of the reinforced concrete beams. There was no load resting on the section of the concrete floors shown. A hot fire in the basement, which contained the hardware stock of a harness and leather concern, caused the damage. The floor slab with reinforced concrete beams, where the latter did not fail completely, deflected as much as 12 inches between the girders in some places. The two reinforced concrete beams, which failed in the rear, are hanging down at the right-hand side. The floor slab is still in position, but has sagged about 18 inches at the centre of the span. Note the sections of the reinforced concrete beams that failed, at the left, still clinging to the floor slab. From a position a little to the left of where the photograph was taken, the rods of the nearest reinforced concrete beams can be seen crossing the cracks in the concrete.

where there are evidences of a very hot fire, such as fused copper, light castings, nails, etc., indicating a temperature of about 2200° Fahr., the reinforced concrete beams failed, and the soffits of the girders being exposed, they deflected badly. There was no load on the floors above, so that the deflections and failures were caused solely by the heat below.

Comments:

The upper portions of the walls were probably shaken down by the earthquake, which no doubt is responsible for the failure of the upper part of the building. The collapse of the N. W. L extension and of the two bays in the middle portion of the building, is probably due to the failure of the reinforced concrete beams or of the exposed columns.

Where the metal frame and walls are yet standing, the concrete floors remain in place, but considerably sagged, and the girders are more or less deflected.

The foundations only can be utilized in rebuilding.

Mutual Savings Bank.

Market, Geary and Kearny Streets.

Wm. Curlett, Architect. Mutual Savings Bank, Owner.

Mahoney Bros., Contractors.

Details of Construction:

The Mutual Savings Bank is a twelve-story bank and office building. Its façades consist of Raymond gray granite for the first two stories and Colusa gray sand-stone above. The building has a well-designed steel frame and grillage foundations. It was built in 1902.

The fire-proof floors are of the Roebling System B or flat slab construction, of stone concrete, 3½″ in thickness, the spans between the beams being about six feet. The partitions are the Roebling 2″ solid plaster type, consisting of ¾″ channel studs at 16″ centres, to which is applied No. 20, 2½ mesh, wire lath, with a ¼″ rod stiffener woven in every 7½″. The lath is laced to the studs at every intersection of the stiffening rods, with No. 18 galvanized wire. The plastering consists of one scratch coat, a brown coat on each side and then the hard finish over these, making a partition 2″ thick when finished. Underneath all the floors above the first, and attached to the under side of the beams with 1″ x ⅛″ mild steel clips, is the Roebling wire lath and plaster flat ceiling. The columns are protected by a double layer of Roebling wire lath and plaster as follows: they are first wrapped with special crimped wire, offsetting the wire surface ¾″ from the column. This is plastered with two coats of cement mortar. The column is then built out to the required size and outline with light steel furring, wire lathed and then finished as usual with three coats of plaster. The soffits of the beams and girders are protected with Roebling wire lath and plaster. The wearing surface of the floors is cement, and in the halls, mosaic.

Effects of the Fire and the Earthquake:

The Geary Street front is very badly spalled and scaled by the fire and must be wholly renewed. The Kearny Street side is comparatively little damaged. The Market Street front is slightly spalled in the three lower stories. This can probably be repaired. The upper stories and the Kearny Street side can be restored by cleaning and slight repairs. The roof tiles, which were attached to T framing at 18″ centres, are badly damaged. Many of the tiles are broken and 40 per cent. are moved more or less out of position. They were attached to the T's by wires which passed through a hole in a lug on the under side of the tile. Being fastened at one point only, they were readily shaken out of position by the earthquake, and many of the lugs were broken.

The levels on the water table show that the foundations remain practically level, the S. E. corner being about ⅜″ lower than the other three corners. The greatest observed variation from the plumb of the walls is ¾″ to the south at the S. W. corner and ⅝″ to the north at the N. E. corner. These variations from the plumb are no more than are found in newly constructed buildings that have not been subjected to earthquakes.

On the ninth, fifth and fourth floors there are evidences of intense heat. Brass, copper, light castings and nails were fused. In many places the copper-plated zinc newel posts of the cast-iron stairs are wholly or partly fused.

The steel frame is uninjured. In some places the plaster has

MUTUAL SAVINGS BANK. Junction of Market, Geary and Kearny Streets. The façades consist of Raymond gray granite for the first story and Colusa sand stone above. This building is structurally uninjured. The foundations are level and the walls remain plumb. The greatest damage sustained by the exterior was on the Geary Street side, which must be wholly renewed, and the tile roof, large portions of which must be rebuilt. The other fronts of the building are but slightly damaged. The Roebling concrete floors and wire-lath ceilings throughout are uninjured. The column protection consisting of a double thickness of Roebling wire lath and plaster, with an air space between, is in first-class condition. All the wire-lath and plaster partitions remain standing, although deflected and buckled out of line in some places.

MUTUAL SAVINGS BANK. Typical view showing the condition of the Roebling concrete floors and the Roebling wire lath and plaster partitions and ceilings. Leaning against the left-hand rail of the stairway is a pile of melted zinc, which was originally a copper-plated newel post. At the extreme left are two slabs of warped marble wainscoting. Note the absence of *débris* on the stairway and in the hallways. The *débris* is limited almost exclusively to a portion of the plaster finish.

MUTUAL SAVINGS BANK. Fourth Story. Showing five large safes and one small one in one of the offices on the Market Street side. The safes were mounted on 8″ x 8″ timbers. The latter burnt out wholly or in part, causing the two safes in the foreground to tilt against the Roebling 2″ wire lath and plaster partition, which remains standing though badly bulged out of line. The three large safes in the rear were overthrown when the timbers burned. The Roebling concrete floors withstood the impact of the falling safes and sustained them safely during the fire.

fallen off of the outside lath covering of the columns, in spots the size of a hand or smaller, but in no case was the inside protection affected. All the wire lath and plaster partitions remain standing, but the studs expanded and bulged, about 20 per cent. of the partitions being out of plumb. All the wire lath ceilings are intact. The cement floor finish warped and cracked in many places. The concrete floors throughout are in first-class condition.

Notwithstanding the fact that there were a large number of heavy safes scattered throughout the building, some of which were thrown flat side down on the floors, not a single safe broke through. Some of the safes were mounted on 8″ x 8″ timbers from which they were shaken by the earthquake. Where the safes remained in position after the earthquake, the fire consumed the skids wholly or in part, which generally caused the safes to drop down on the floor or tilted them over. On the fourth floor, at the Market Street side, one small office contained five large safes and one small one. These were mounted on timbers. Two of these, on account of the sleepers being partly consumed, tilted against the 2″ partition back of them, bulging out the partition (which remained standing). Three other safes, 3′ x 4′ x 6′ high, were thrown bodily forward on the floor, but did no damage except that one of them punctured the floor, making a hole about 10″ x 20″ in size. This is the only damage to the floors that was noted in the entire building. The other small safe in the room referred to remains standing on the floor.

The elevator fronts and the cast-iron stairways with marble treads are only slightly damaged. The large banking room and entrance hall on the ground floor are discolored by smoke and the ornamental plaster work and marble veneering is damaged. The mechanical equipment in the basement is only slightly damaged.

Comments:

This building undoubtedly has a first-class foundation. The workmanship and materials are of the best. It withstood the earthquake and fire without any structural damage whatever. The floors and wire lath ceilings are intact. While all the partitions remain standing, new door and sash framing will be required, and a portion of them (approximately 15 per cent. or 20 per cent.) on account of being out of plumb, will have to be rebuilt. All the plaster is badly damaged by the fire, and will have to be removed and new work substituted. The damage to the equipment, elevator fronts, stairways, cement floor finish and roof tiling can be repaired. All the fixtures, piping, tubing, mail chutes, etc., will require complete renewal.

Kamm Building.

South Side of Market Street, near Third Street.

Bliss & Faville, Architects. Jacob Kamm, Owner.

Details of Construction:

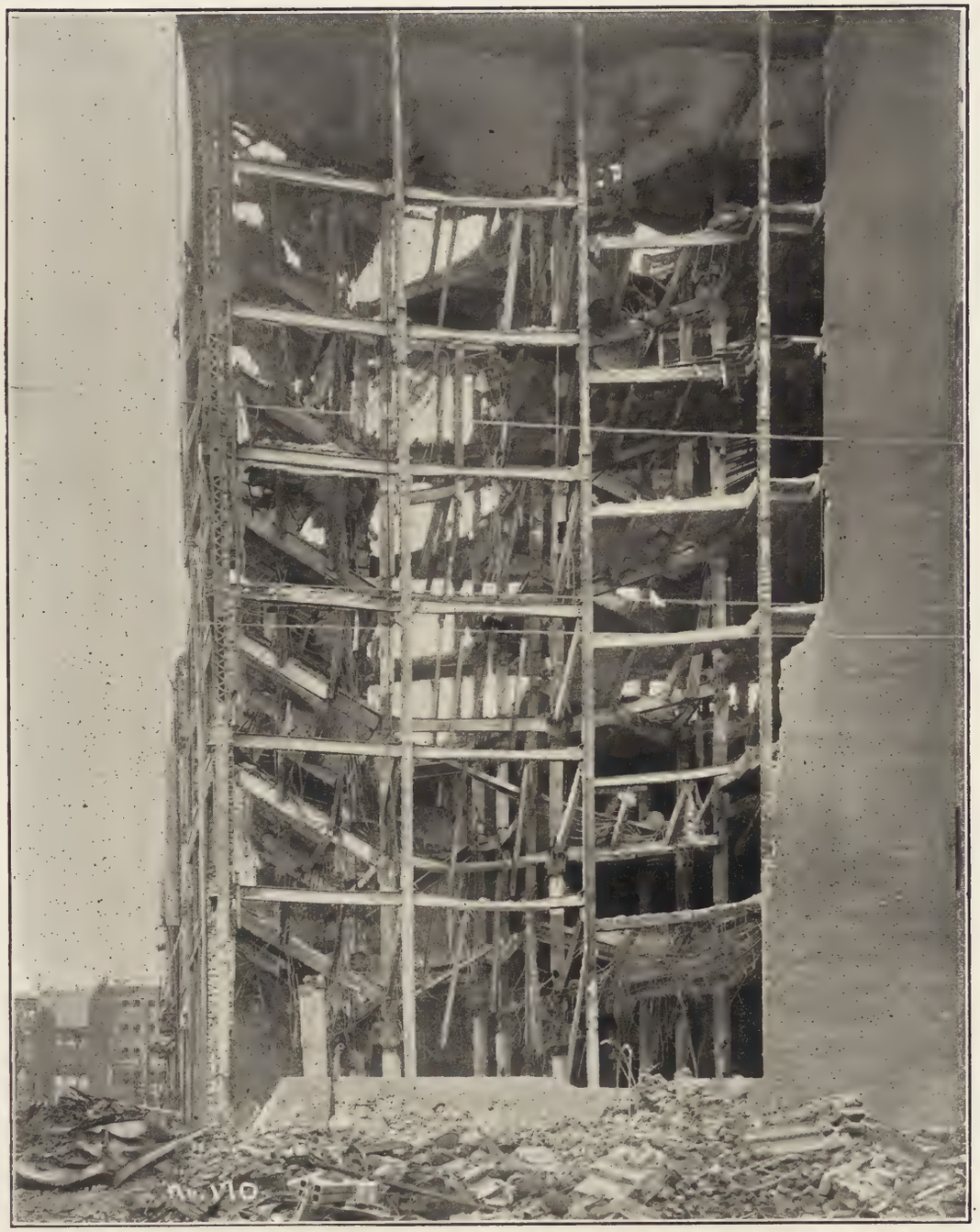
This is a seven-story store and loft building. The façade consists of Colusa sand-stone and ornamental cast iron for the first story, Colusa sand-stone for the upper stories and a metal cornice. The building is of steel construction, the walls being self-supporting. The fire-proof floors are of the Roebling System B or flat slab construction of stone concrete 3½″ in thickness, the spans between the beams being about 6 ft. The partitions are of the Roebling 2″ solid type throughout, excepting in the first story, where the partitions are of the hollow type, finishing 4″ in thickness. In the latter partitions, the studs at 16″ centres consist of two channels, 2½″ outside to outside, tied together by straps at intervals of about 3 ft. On both sides of these studs is laced the Roebling wire lath, stiffened with a solid rod woven in every 7½″. This partition is finished by three coats of plaster on each side.

The hollow partitions also enclose the stairway wells and the elevator shaft on two sides, the other two sides being of the 2″ solid plaster type. A suspended wire lath ceiling is erected over the top story. The steel columns throughout are protected by light steel furring and Roebling wire lath finished with three coats of plaster. The soffits of the girders and beams are protected with crimped wire lath and cement plaster. The floor finish was in wood, laid over sleepers and sleeper fill.

Effects of the Fire and the Earthquake:

The ornamental front of the building is very little damaged, except that the metal cornice has fallen away. The sand-stone

KAMM BUILDING. South Side of Market Street, near Third. The façade consists of Colusa sand-stone, which remains in first-class condition. The metal cornice has fallen away. The rear half of this building was wrecked by the failure of columns in the basement story, where a large stock of highly inflammable wall paper furnished fuel for a fire that burned continuously for a whole month. In the front portion of the building, where normal conditions prevailed, the steel skeleton frame and the Roebling concrete floors and wire lath and plaster column protection are in first-class condition. The Roebling wire lath and plaster partitions remain standing, but are deflected out of plumb in some places. The illustration shows also one-half of the front of the Spreckels Building Annex on the left-hand side.



KAMM BUILDING. Showing the collapsed rear portion of the building caused by column failures in the basement. The tenacity of the connections of the wall girders at the columns is remarkable. Two beams framed to them, when carried downward in the centre, have twisted the girders in the middle section through an angle of about 80 degrees from the vertical. The Roebling concrete floors cling to the beams; seven tiers in the rear of the building being inclined at an angle of about 35 degrees, and other sections of the floors being warped and distorted into almost every conceivable shape. Note the curved skyline of the rear where the central columns have been drawn inward by the collapse.

KAMM BUILDING. Looking into the wrecked rear portion from Stevenson Street. The basement of this building was used as a store-room for a wall-paper concern, and was filled solidly with stock. The heat from the burning of the wall-paper stock buckled the columns to the extent of 6 or 8 ft. of their length and wrecked the entire rear portion of the building. The fire in the basement was still burning on May 19th, when this building was inspected, a month after the origin of the conflagration. Note the concrete floor slabs, though cracked and badly injured, still clinging to the steel beams. The soffit protection of the beams is wonderfully tenacious.

KAMM BUILDING. Second Story. Showing a buckled column near the floor level. The portion of the building shown in the photograph was occupied by a wall paper concern, and contained large quantities of stock. The paper was consumed, leaving ashes in the form of the original rolls. The man in the photograph is standing knee deep in white ashes, which are 4 feet deep at the wall in the rear. Note the condition of the Roebling concrete floors and beam soffit protection overhead. These were subjected to a hot and long-continued fire, without materially affecting the concrete floors or destroying the crimped wire lath and cement plaster soffit protection of the beams and girders. The settling of the floors, caused by the buckling of the column, caused cracks along the haunches of the beams, which in this form of construction did not weaken the floor slab.

KAMM BUILDING. Seventh Story. Showing the rear collapsed portion of the building at this level, looking southeast. The water tank at the right fell from the roof and was held by a section of Roebling concrete flooring that was still supported by the steel work. Note the furring and lathing of the columns which still remains generally in place after the plaster has been jarred and stripped off by wreckage.

KAMM BUILDING. Fifth Story. From within, looking into the rear portion of the building, which was wrecked by column failures in the basement. The Roebling concrete floor slabs of seven tiers at the rear end of the building are inclined at an angle of about 35 degrees, and remain generally in place. This view was taken to show a badly buckled latticed channel column in the centre foreground which was caused by abnormal strains and loads, and not by heat. Note the tenacity of the crimped wire lath and cement plaster soffit protection, which remains in place after the wreckage has destroyed the floor slabs.

is slightly spalled around the openings in the upper stories. There are no earthquake cracks.

The entire rear portion of the building was wrecked by the failure of seven columns in the basement. A wall-paper concern occupied the lower stories of this building and had a storage room in the basement. The latter was solidly filled with a stock of wall-paper, which made an intensely hot fire of long duration. On May 19th, just a month after the original conflagration, the fire was still burning in a blaze in the basement, which story could not be touched by workmen who were clearing up *débris* in other parts of the building.

The south half of the east and west walls and the entire rear wall are down, but the distorted steel frame is still standing. The settling of the interior columns in the rear portion has broken many of the connections of the beams and girders away from them, so that the latter hang to the wall columns, with sections of the concrete floor still adhering to them in many cases. The front half of the building is in good condition. The metal frame is uninjured. The concrete floors are in first-class condition. The partitions remain standing, but a small percentage are buckled out of plumb. The stairway and elevator fronts are greatly damaged. The seventh story was divided into small offices. A tank on the roof in the rear dropped to the seventh floor, carrying part of the roof framing with it when that portion of the building collapsed.

Comments:

In this building is illustrated in a very conclusive manner the fact that ordinary methods of column protection are insufficient for buildings in which a large quantity of inflammable material is stored. This building was designed as a loft building, the plans specifying a single layer of wire lath and plaster protection for the columns. Had it been occupied throughout as a loft or light factory as planned, and had it contained only the ordinary furniture and equipment of such a building, the rear portion would no doubt have withstood the fire as well as the forward portion. The vast quantity of highly inflammable paper, however, that was stored in the basement and second and fourth stories in the rear of the building, without doubt created a fire of longer duration than that in any other building in the city, and produced sufficient heat to have caused the failure of the same columns, even had they been protected by a much more efficient covering. This building therefore is a particularly interesting one from the standpoint of column protection.

The building laws of every city should be so drafted that it would be impossible for a building designed for one purpose to be used for another which involved the storage of larger quantities of inflammable goods or materials. This building also illustrates the necessity of making special provision for the protection of the columns, girders and other important structural members in all buildings which are to contain large quantities of combustible contents.

The entire rear portion of the building will require reconstruction. The forward portion can be repaired and occupied while the rear portion is being rebuilt.

Aronson Building.

N. W. Cor. Third and Mission Streets.

Hemenway & Miller, Architects. A. Aronson, Owner.

Details of Construction:

The Aronson Building is a nine-story store and loft building, about 80′ x 90′ in plan. The façades consist of Colusa sandstone for the lower three stories and buff pressed terra cotta brick with terra cotta ornaments above. The cornice is of terra cotta and copper. The west and south walls are of common brick, and all the walls are self-supporting.

The floors are supported by steel columns, girders and beams. The fire-proof floors are of the Roebling System B or flat slab type of stone concrete, the spans being about 6½ ft. between beams. The partitions throughout are of 4″ hollow tile blocks. The steel columns are protected with 3″ hollow tile blocks except two in the basement which have concrete protection. The soffits of the girders and beams are covered with crimped wire lath and cement plaster. The floor finish was of wood, laid on sleepers and sleeper fill.

Effects of the Fire and the Earthquake:

The sand-stone of both fronts is badly spalled by the fire, and on the Third Street side it is considerably cracked by the earth-

ARONSON BUILDING. Northwest Corner Third and Mission Streets. The façades for the three lower stories consist of Colusa sand-stone, which is badly spalled and damaged. The upper stories of buff terra cotta pressed brick, with terra cotta ornaments, are but slightly injured, the terra cotta being spalled and cracked in a few places. The metal cornice is completely wrecked. The rear walls of common brick were considerably racked and damaged by the earthquake. All the walls remain practically plumb. Columns in the basement, first, fifth, eighth and tenth stories have buckled on account of the failure of the hollow tile protection. The Roebling concrete floors, with crimped wire lath and cement plastered soffit protection, remain in first-class condition throughout, notwithstanding the warped condition of the steel work, due to the buckling of the columns. The 4″ hollow tile partitions are badly wrecked throughout, about 80 per cent. of the entire work having fallen down. The failure of the hollow tile partitions totally wrecked the cast-iron and marble tread stairways.

ARONSON BUILDING. Basement Story. The failure of the hollow tile column protection caused the column to buckle, letting down the floors above about two feet. The Roebling concrete floors are in good condition. Note the soffit protection clinging to the girder in the upper right-hand corner.

ARONSON BUILDING. First story. Showing the buckling of two columns near the ceiling line, left of the centre. The hollow tile column protection and partitions are badly wrecked in this story. The bulging of the pipes probably caused the failure of the protection of the buckled column on the left. The Roebling stone concrete floors with crimped wire lath and cement plaster soffit protection are uninjured, although the buckling of the columns shown caused the floors above to settle about 18 inches. The falling of the hollow tile partition blocks enclosing the stairway in the rear wrecked it.

quake. The pressed brick and terra cotta above is in good condition. At the third-story level the walls between window openings are badly cracked by the earthquake. The northeast corner at the first story is badly racked. The north and west walls of common brick are in fair condition. All the walls are practically plumb, the greatest variation from the plumb being at the southeast corner, where the south front leans to the north about 3/8″. The levels on the water table do not disclose any material displacement of the foundation.

One of the columns in the basement on the east side has buckled. In the southwest corner of the first story, two columns have buckled near the ceiling. The failure of one of these was caused by the bulging of pipes within the fire-proof protection. In the northwest corner in the fifth story, one of the columns buckled so that the floors settled about 18″. On the eighth floor, in the northwest corner of the building, another column is badly buckled. The same column on the tenth story buckled also. One column deflected slightly in this story.

The concrete floors throughout are in first-class condition, successfully carrying a number of large safes that were located in different parts of the building. The 4″ hollow tile partitions are generally wrecked, about 60 per cent. of the entire work having fallen down. The wall furring is badly cracked, and is down in spots. The hollow tile column protection is greatly damaged throughout, 50 per cent. or more having fallen away from the columns of the first story, and approximately an average of about 15 per cent. has fallen away from the columns in the other stories. The concrete column protection in the basement is in fair condition, although not of good quality originally. The 4″ tile partitions around the stairway and elevator enclosure on the north side collapsed throughout, many of the blocks falling on the stairway and wrecking it.

The wire lath and cement plaster on the soffits of the beams and girders is in good condition. The suspended wire lath and plaster ceiling on the top story is intact. The cast-iron stairway and elevator fronts on the west side are greatly damaged and the stairway on the north side is completely wrecked.

Comments:

The intensity and duration of the fire was normal and such as would naturally result from the combustion of considerable stock, wood finish, furniture, etc., in a building of this character. The sand-stone portions of the front will require renewal. The several columns that have been buckled can be replaced. The elevator fronts, stairways, partitions, column protection and all the plaster work must be completely renewed and rebuilt.

An opportunity of comparing the efficiency of hollow tile blocks and concrete for column protection was afforded in the basement, where both materials were used for this purpose. One of the columns covered with hollow tile blocks buckled very badly, and the protection is damaged around other columns. The columns protected by concrete remain straight and uninjured, although one of them is within 15 ft. of the badly buckled column referred to and was apparently subjected to the same conditions.

Sloane Building.

North Side of Post Street, between Grant Avenue and Stockton Street.

Newton J. Tharp, Edward Holmes, Architects. Crocker Estate, Owner.

Details of Construction:

The Sloane Building is a seven-story building that was occupied as a furniture store. The façade consists of terra cotta for the first story and pressed terra cotta buff brick and terra cotta ornaments for the upper stories. The cornice is also of terra cotta. The metal frame consists of cast-iron columns, with steel girders and beams.

The fire-proof floors are of the expanded metal, flat arch type, 3½″ in thickness, the spans between the beams being about 6½ ft. The floor slab is of cinder concrete with No. 16, 3″ mesh expanded metal imbedded in it.

The partitions enclosing the elevator shaft and stairway are 3″ in thickness, of expanded metal and plaster. The wall furring consists of 1″ flat bars stapled to the walls, over which is laced expanded metal lath, and is finished with three coats of plaster. The cast-iron columns are protected with expanded metal lath and plastering, except in the basement where they are exposed. The soffits of the girders and the beams are also lathed and plastered.

SLOANE BUILDING. North Side of Post Street between Grant Avenue and Stockton Street. The façades consisting of terra cotta for the first story and pressed terra cotta buff brick and terra cotta ornaments above, are in fair condition. The ornamental terra cotta is spalled considerably, but the pressed brick remain in fair condition, except several spots where the bonding has been broken by the earthquake and they have fallen away. Sections of the rear walls, near the top, have fallen down. On account of being left exposed, six interior cast-iron columns in the basement failed from the fire and wrecked a large portion of the interior of the building. The small sum of $300.00 devoted to the suitable protection of these columns would no doubt have saved $50,000.00 in the cost of the repairs to this building.

SLOANE BUILDING. First Story. Showing damage caused by the failure of unprotected columns in the basement. Note the concrete clinging to the distorted steel work and hanging down in sheets where the supports have been removed from one side.

Effects of the Fire and the Earthquake:

The front of the building is only slightly damaged, the terra cotta mullions and ornamental work being spalled. The terra cotta ornaments over the window heads on the east side are also spalled. Some of the face brick of the lower stories on the east side are down. These were bonded only every seventh course. The terra cotta cornice is cracked and spalled and considerably damaged in a number of places. One-half of the north wall in the sixth and seventh stories fell inward. The seventh story wall of the northwest L extension fell outward.

There are evidences showing that there was a fire of great intensity in the basement. In this story there are three interior columns on the north side and three interior columns on the south side that failed, wrecking the entire central portion of the building, which is open to the roof. Three bays on the north side of the building also collapsed and fell into the basement. Many of the girders and beams that still remain in place in the first floor are out of line and deflected.

The columns and steel beams and girders above the first story in the portions of the building that have not been wrecked, are in fairly good condition. The concrete floors are also in good condition. The partitions around the elevator and stairway are badly damaged and out of plumb, but still standing. The elevator fronts and cast-iron stairway are in bad condition.

The levels on the water table indicate that the foundation is practically level. The greatest observed variation of the walls from the plumb is at the southeast corner, where the east wall leans to the east about $\frac{1}{4}''$.

Comments:

On account of the columns in the basement being unprotected, the interior of the building is so badly wrecked that it will be necessary to reconstruct it. The foundations and a large part of the ornamental front can be utilized; also a portion of the metal frame.

The cause of the collapse of the central portion of this building was no doubt due to the failure of the columns in the basement, which were unprotected and exposed to a severe fire. The columns that failed, where they could be inspected and were not covered by *débris*, showed distinctly that the failures were caused by heating; in one case a portion of the column telescoping around the other. It is probable that had so small a sum as $300 been spent in protecting these columns, many thousands of dollars would have been saved in repairing the wreck and damage caused by leaving them exposed.

Rialto Building.

S. W. Cor. New Montgomery and Mission Streets.

Fred Meyer, Architect. Mrs. Hermann Oelrichs, Owner.

Details of Construction:

The Rialto Building is nine stories in height and was used for stores and offices. The façades consist of buff terra cotta pressed brick with terra cotta lintels and a terra cotta cornice.

The building has a steel frame with grillage foundations. The fire-proof floors above the first are of the expanded metal, flat arch type, of stone concrete $4\frac{1}{2}''$ thick, the spans being 9 to 10 ft. between beams. The floor slab is further strengthened by $\frac{1}{2}''$ square Johnson steel bars at 16″ centres. Underneath the floors are expanded metal lath and plaster flat ceilings throughout, except in the basement. In the first floor the spans between beams are $6\frac{1}{2}$ ft., and the regular expanded metal flat arch of cinder concrete was placed in this tier.

The steel columns are protected by two layers of expanded metal and plaster, except in the basement, where they are protected by a single layer only. The soffits of the girders and the beams in the basement are lathed with expanded metal and plastered. The partitions consist of 3″ hollow tile blocks.

The floor finish was of wood with sleeper fill, except in the halls, which were finished with marble tiling. The wall furring consists of $1\frac{1}{2}''$ hollow tile blocks.

Effects of the Fire and the Earthquake:

The terra cotta of the main entrance is badly cracked by the earthquake. The terra cotta mullions in the upper story are considerably spalled. The pressed terra cotta brick-work is in fair condition. The southeast corner of the building is badly racked by the failure of columns inside. In the Mission Street

RIALTO BUILDING. Southwest Corner New Montgomery and Mission Streets. Showing the Mission Street wing (about one-half of the building). The exterior is only slightly damaged. Note the characteristic earthquake damage to the piers at the fifth and sixth story levels at the right. A small section of the interior of this wing of the building was wrecked, as is shown, and a much larger section in the other wing of the building was similarly wrecked. Both failures were caused by insufficient column protection in the basement. The concrete floors and the metal lath ceilings and column protection are in good condition. The hollow tile partitions are badly damaged and wrecked in many places.

RIALTO BUILDING. Basement Story. Showing a bad column failure under the wrecked portion of the building on the New Montgomery Street side. The concrete floors remain in place, notwithstanding the great distortion of the steel work.

RIALTO BUILDING. Basement Story. Showing a buckled column under the wrecked portion on the New Montgomery Street side. Falling *débris*, sufficiently heavy to break down a section of the flooring, only cracked the soffit protection, which is still adhering to the beams.

RIALTO BUILDING. First Story. Showing the failure of the light-gauge, expanded metal lath and plaster ceiling. A fire of considerable intensity occurred in this story, causing the failure generally of the hollow tile partitions as well as the ceiling. Note that the wire ties, which originally held the expanded metal in place, remain on the furring bars, showing that the light-gauge, expanded metal was incinerated and broke away from the wire supports. The photograph was taken after the metal lath and plaster column protection had been completely removed from the columns and the partition blocks had been piled on the left, as shown.

RIALTO BUILDING. First Story. Looking toward one of the collapsed sections of the building. Showing the typical condition of the double expanded metal lath and plaster column protection and the 3″ hollow tile partitions. The fire-proof floors are of stone concrete with ½″ sq. Johnson steel bars at 16″ centres and No. 16. 3″ mesh expanded metal imbedded in it. The flat ceiling of expanded metal lath and plaster has failed in numerous places.

RIALTO BUILDING. First Story. Looking from the building line near the New Montgomery Street entrance. Showing a collapsed section caused by the buckling of a column in the basement story.

RIALTO BUILDING. Looking across the light court from one wing of the building toward the other wing, the interior of which was wrecked by buckling columns in the basement. The strength and tenacity of the steel connections are noteworthy. The beams connected to the wall girders midway between columns frequently twisted the girder through an angle of 75°. Some of the concrete floor slabs are still hanging in vertical positions at the sides.

RIALTO BUILDING. Basement Story. Showing the unprotected steel at the building line where the vents were carried up underneath the first story show windows from the basement. The glass prisms of the sidewalk lights fused, the glass hanging in shreds as shown. Note also the earthquake damage to the supporting concrete pier. Compare this with the illustration on the opposite page.

RIALTO BUILDING. Basement Story. Showing the adjoining bay of unprotected steel at the building line, but with the floor beams partially fire-proofed with concrete. This small amount of protection prevented the floor beams from buckling, and caused the unprotected girder to deflect instead. Compare this with the illustration on the opposite page. Vents of this character are extremely bad practice from a fire-proofing standpoint, and when employed, the structural steel should be very carefully protected.

RIALTO BUILDING. Fourth Story. Showing splice and connections of a typical column in this story. All the columns in the building change from a larger to a smaller section at this level, producing a structural weakness which caused characteristic X cracks in all the piers between the windows in the fourth and fifth stories.

front, the bond of the face brick is broken and sections have fallen off. Above the fifth story floor the mullions and piers are racked and cracked by the earthquake.

In the northwest corner, six bays have entirely collapsed and fallen into the basement, except three bays of the roof tier. In the basement of the southeast wing, three columns failed by buckling. One of the interior columns in the northwest corner of the building, in the eighth story, also buckled, the double lath and plaster protection having been broken away by a pipe inside of the protection, which bulged and disrupted the covering. At the northeast corner on the Mission Street side the steel work at the sidewalk level is considerably distorted.

The levels on the water table show that the foundations are practically level and evidently in good condition. The greatest observed variation of the walls from the plumb was at the southeast corner, where the south wall leans to the south 1½″. At the northeast corner, the north wall leans to the south about ⅝″.

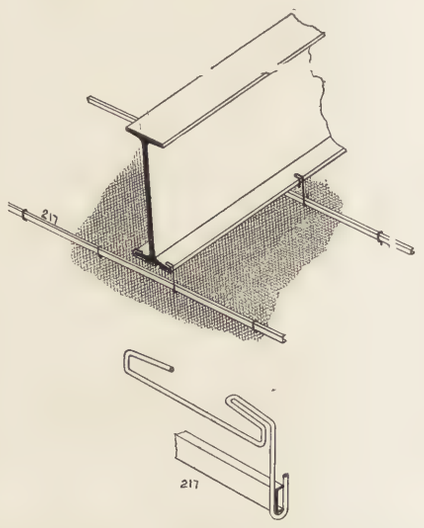
The concrete floors in the sections of the building that have not collapsed are in first-class condition. The expanded metal lath and plaster ceilings, however, failed quite generally, on account of a very weak form of wire clip that was used to support the ceilings from the beams. The hollow tile partitions are down in many places and the hollow tile wall furring is off in spots and considerably cracked.

The cast-iron stairway with marble treads is in fair condition, except that the marble treads are broken in many places and badly damaged. The copper plated zinc newel posts and rails are partly fused in some places and considerably damaged. The elevator fronts are bulged and distorted, and the framing is out of line.

Comments:

It is noticeable that there was a decided structural weakness at the fourth and fifth story levels, the piers between windows and the corners of the building showing characteristic earthquake cracks and considerable damage at those levels.

An examination of the interior columns disclosed the fact that all the sections were changed at the fourth story level, which probably was one of the causes which contributed to this result. The splicing of the columns should be distributed at different floor levels, so as to eliminate any weakness due to such connections as far as possible. The failure of the column on the eighth story, where the double lath and plaster protection was forced off by a bulging pipe, is further convincing proof of the undesirability of permitting piping inside of the column protection. The mistake of omitting the double lath and plaster protection of the columns in the basement is no doubt largely responsible for the failure of the columns in that story, and caused many thousands of dollars' worth of damage by wrecking large sections of the building.



Wire Ceiling Clip that Failed in Moderate Fires.

The failure of the ceilings, where the metal lath and plaster fell away from the supports, was due to the light wire clip, designed as shown in the accompanying sketch. These clips were made of about No. 8 wire, and bent to the form shown, around the lower flange of the beams. The hooked end projecting downward supported the channel iron furring at 12″ centres. The metal lath was laced to the channel iron furring and the plaster applied to the lath surface.

The light section of the wire clip was quickly heated when exposed to fire, and thus weakened, it straightened out, permitting the entire ceiling construction to fall away from the beams in many places. Ceiling clips of such light sections are undesirable, and should not be used where an efficient and fire-resisting ceiling construction is required.

It is probable that a large portion of this building can be repaired and occupied while the collapsed portions are being rebuilt.

ATLAS BUILDING. 604 Mission Street. The walls are of common brick with cementine finish. The "X" cracks between the windows and the spalling of the corners of the walls are characteristic features of the earthquake. On account of the inexpensive exterior finish of this building, the repairs will probably cost much less than in cases where the façades are of stone or terra cotta. The fire entered from the rear, consuming the interior of the upper stories only, and causing comparatively little damage below. The floors are of concrete, and the partitions of metal lath and plaster. The low two-story building at the right escaped the fire, and is but little damaged.

ATLAS BUILDING. Typical view of the lower stories. Metal lath and plaster partitions and ceilings, cement finished floors. The cracks in the plaster were caused by the earthquake and the dark color by smoke.

Atlas Building.

No. 604 Mission Street.

Frank S. Van Trees, Architect. H. E. Bothin, Owner.

Details of Construction:

The Atlas Building is ten stories in height, and was used as a store and office building. It was only recently completed, and tenants were just moving in at the time of the fire. The façade consists of ornamental cast iron for the first story and common brick with cementine plaster finish above. The cornice is of galvanized iron. This building is of steel skeleton construction with curtain walls. The fire-proof floor construction is of concrete. The partitions are of wire lath and plaster. The columns and the soffits of the beams and girders are protected with wire lath and plaster.

Effects of the Fire and the Earthquake:

All the outside walls show cracks, probably caused by the earthquake, from the fourth to the eighth stories, the cracks being generally in the form of the letter "X" between window openings. At the N. W. corner the brick is spalled considerably. There was comparatively little fire in this building. The west wall is of brick without openings. The east wall has openings above a two-story building which escaped the fire. The flames from adjoining buildings entered the Atlas Building through the windows on the north side and consumed all the combustible contents in the upper stories. The lower stories and elevator halls are practically undamaged, except by plaster cracks and by smoke. The fire-proof floors in the portions of the building that were burned are in good condition. The partitions also stood, but are bulged out of plumb in some cases. The steel frame is uninjured. The elevator fronts, framing and power plant are very little damaged. Some of the marble treads of the cast-iron stairway are damaged.

Comments:

With the exception of the walls, which are badly cracked, this building is comparatively little damaged, and can be repaired without serious difficulty. The cracks observed are characteristic of all those that have been caused elsewhere by the earthquake.

Bullock and Jones Building.

North Side of Sutter Street, between Montgomery and Kearny Streets.

Hemenway & Miller, Architects. A. Aronson, Owner.

Details of Construction:

This is an eight-story building that was used for lofts. The façades consist of cream terra cotta and glass for the first two stories and pressed terra cotta brick with terra cotta ornamentation above. The cornice is of metal. The walls are self-supporting, the metal frame being of steel.

The fire-proof floors are of the expanded metal, concrete flat arch type, the spans between beams being about 7 ft. The partitions enclosing the elevator shaft and the stairway are of the hollow type, consisting of sheet-steel studs 2½″ wide, with expanded metal applied to both sides and finished with plaster.

The columns are protected by 3″ hollow tile blocks. The soffits of the beams and girders are protected by expanded metal and plaster. The floor finish is of wood, laid over sleepers and sleeper fill. The pent house on the roof has walls of 6″ hollow terra cotta blocks.

Effects of the Fire and the Earthquake:

The terra cotta and glass of the first two stories of the Sutter Street front is completely gone, having been destroyed by the fire. The terra cotta of the upper stories of the Sutter Street front, as well as that of the east and west sides, is badly spalled and cracked.

The window openings in this building are exceptionally large, and the terra cotta around them is badly damaged in many places. Much of the injury to the terra cotta piers between the windows was probably wrought by the earthquake.

At the northeast corner of the building, at the fourth and sixth story levels, portions of the brick work have fallen away. The wall of common brick on the north side is bulged in spots. The west wall is in fair condition. The metal cornice is badly damaged.

The levels on the water table show that the foundations are practically level and evidently in good condition. The greatest observed variation of the walls from the plumb was at the southwest corner, which leans approximately 1″ to the west. The east wall, at the southeast corner, leans about ⅜″ to the west.

BULLOCK AND JONES BUILDING. North side of Sutter Street, between Montgomery and Kearny Streets. The façades consisting of cream terra cotta and glass for the first two stories and pressed terra cotta brick, with terra cotta ornamentation above, are badly damaged, and the metal cornice is wrecked. Two columns are buckled in the third story near the middle of the building on account of the failure of the 3″ hollow tile protection. The steel beams around the stairway and elevator walls were unprotected and bulged inward. The expanded metal concrete floors are in good condition. The hollow expanded metal lath and plaster inclosures of the elevator shaft and stairway are badly deflected, but remain standing. The hollow tile column protection is ruptured in many places, and a large proportion of it has fallen away. Bulging pipes, as usual, have contributed to this damage.

BULLOCK & JONES BUILDING. First Story. Showing the condition of the expanded metal concrete floors, and the hollow tile partitions and column covering. The expanded metal lath and plaster partition around the elevator shaft is standing, but has deflected out of plumb. The Cutler mail chute is bulged on account of the expansion due to the heat. The opening through the second floor at the upper right hand is the same shown in the succeeding illustration.

BULLOCK & JONES BUILDING. First Story. Showing the bulged and warped steel framing around the stairway openings in the first and second floors. The steel beams in the ceiling of the second floor bulged inward toward the opening, removing the support of the two adjoining arches, allowing them to drop down into a vertical position supported by the beams on the opposite sides. Note the settling of the floor slab on the right hand side of the opening on the first floor, and the bulging of the beam which originally supported it. The hollow tile column protection failed badly. A wire lath and plaster partition is standing in the rear on the right.

BULLOCK & JONES BUILDING. Third Story. Showing the failure of the hollow tile column protection and the consequent buckling of two columns. The pipes within the column protection no doubt forced it off when they became heated and bulged by expansion. A metal lath and plaster partition remains standing on the right-hand side. The concrete floors are in good condition and in place, notwithstanding the settling of the columns and the distortion of the steel beams and girders. Note also the bulging of the steel beams in the stairway opening, due to unprotected facias.

BULLOCK & JONES BUILDING. Eighth Story. Showing the failure of the column protection, and the buckling of the column as a consequence. The corner beads of the shaft enclosure in the rear and of the pilaster around the wall chace expanded and cracked the plaster adjacent to them.

The fire in this building was considerably more severe than that which would ordinarily occur in an office building. In the third story, two columns in the middle of the building are buckled. All the beams and girders around openings are bulged by expanison. In the second floor two arches adjoining a stair opening failed from this cause. In the eighth story, one of the lattice channel columns is buckled. Two small columns supporting the roof of the pent house are badly sprung.

With the exception of the few arches that failed on account of the displacement of the steel supports, the rest of the concrete floors are in first-class condition. The expanded metal and plaster enclosures of the elevator shaft and stairway are standing, but are considerably bulged and out of line in some places.

The 3″ hollow tile column protection is ruptured in many places, and a large proportion of it has fallen away from the columns. Much of the failure of the column protection was caused by bulging pipes, as usual. In the fifth, sixth and seventh stories, very little column protection remains in place. The elevator fronts and cast-iron stairway are badly distorted and damaged.

Comments:

The ceilings in this building were panelled, the soffits of the beams and girders being protected simply by expanded metal lath and plaster. This protection was sufficient to so protect the beams and girders that very few of them were permanently deflected by the heat. The building is not damaged as much as might be supposed from the external appearance of it. The buckled columns can probably be replaced and the exterior repaired without serious difficulty.

In this building is clearly pointed out the necessity of protecting the exposed structural steel in floor openings.

Murphy Building.

N. W. Cor. California and Kearny Streets.

Shea & Shea, Architects. Murphy Estate, Owner.

Details of Construction:

This is a five-story store and office building. The façades consist of cast iron and glass for the first story and terra cotta above. The cornice is of metal. This building has a steel skeleton frame with curtain walls.

The fire-proof floors are of the expanded metal, flat slab type, of cinder concrete, with No. 16, 3″ mesh expanded metal imbedded in it. The spans are about 7 ft. between beams. Underneath all the floors is a flat, expanded metal lath and plaster ceiling, the soffits of the beams and girders above being left exposed.

The partitions are of the hollow, expanded metal lath and plaster type, the studs at 14″ centres consisting of 1″ x ⅛″ flats tied together with straps so that they are 3½″ from outside to outside. The metal lath is applied to both sides of these studs, and the partition is then finished with three coats of plaster.

The roof is supported on light trusses with a hung ceiling of expanded metal and plaster underneath. The wall furring consists of expanded metal on ½″ x 1/16″ flats at 12″ centres. The large bay windows and framing were supported by cantilever construction.

The steel columns consisted of 4 angles, latticed. The interior of these was filled solidly with concrete, and they were protected by light steel furring and expanded metal lath, with three coats of plaster.

The floors were finished in wood laid over wood sleepers and sleeper fill.

Effects of the Fire and the Earthquake:

The fronts at the ground level are little damaged, except that the glass has been destroyed. The terra cotta work above is considerably spalled and will require renewal at many places. A large portion of the area of the fronts is taken up by bay windows. With the exception of the floors, these consisted of wood work, glass and copper. The concrete floor projections and the supporting beams are in good condition. The light steel vertical framing supporting the window frames is badly distorted and out of line. A large portion of the cornice is down.

The fire in this building was normal, consuming everything that was of a combustible nature. The steel skeleton frame is in good condition. The light steel framing of the elevator shaft is much distorted and damaged. The filling of the light latticed columns with concrete no doubt added greatly to their fire-re-

MURPHY BUILDING. Northwest Corner California and Kearny Streets. The burning of the large bay windows which were almost wholly of wood construction and finish, distorted the vertical steel framing. The expanded metal concrete floors and metal lath ceilings are in good condition in this building. The metal lath and plaster partitions are considerably sprung out of plumb.

sisting qualities, and none of these appear to be damaged, although only protected on the outside with a single layer of lath and plaster.

The concrete floors are in first-class condition. The ceilings underneath successfully protected the soffits of the beams and girders above, and are intact with most of the plaster still adhering to them. The hung ceiling under the roof trusses withstood the fire remarkably well and protected the trusses against damage. A 5′ x 5′ skylight in the roof, with a metal frame and glazed with wire glass, remains in good condition, and probably by preventing a draught through the top of the building rendered the fire less destructive.

The partitions are all standing, but in some places they have buckled out of line. The wall furring is generally intact and apparently in good condition. The elevator fronts and cast-iron stairway with metal treads are in fair condition and can be repaired.

Comments:

The light steel furring and metal lathing in this building was well executed and showed good results after the fire. The studs in the partitions were fastened between rigid supports, top and bottom, so that there was no opportunity for expansion. This caused considerably more buckling of the partitions than would have been the case had suitable provision been made to allow for expansion.

This building is very little injured structurally, and the repairs can be made without difficulty.

Security Savings Bank.

East Side of Montgomery Street, between California and Pine Streets.

Nathaniel Blaisdell, Architect. Security Savings Bank. Owner.

Details of Construction:

This is a two-story bank building. The façade is of white marble with granite base to the water table. The side and rear walls are of brick and are bearing walls. Being only about 25 feet in width, there are no interior columns.

The floor construction is of the expanded metal flat slab type of stone concrete. The spans being about 6′ between beams. The partitions are of 3″ hollow tile blocks. The floor finish was of incombustible material on the first floor and of wood in the second story.

Effects of the Fire and the Earthquake:

The fire caused comparatively little damage to this building. The earthquake spalled the upper part of the front slightly. A class "B" building occupied by the California Safe Deposit and Trust Co. on the north side of this building was destroyed by fire. The south wall fell over and broke down the roof and floors of the Security Savings Bank, causing practically all the damage to the latter building.

Comments:

The walls of the adjoining class "B" building should have been tied together by rods or anchored to the metal frame. The south wall would then have fallen inward instead of outward, and thus saved all the structural damage to the Security Savings Bank.

Telephone Co.'s Main Office.

South Side of Bush Street, between Grant Avenue and Kearny Street.

Alexander A. Cantin, Architect. Pacific States Tel. and Telegraph Co., Owner.

Details of Construction:

This is an eight-story building, and was intended to be occupied as their main office by the Pacific States Telephone and Telegraph Co. It had just been completed, and the Telephone Company was moving in at the time of the fire. The façade consists of buff terra cotta pressed brick with terra cotta ornamentation. The cornice is of metal. The metal frame is of steel, the walls being self-supporting.

The fire-proof floors are of the Roebling System B or flat slab type, of gravel concrete, the spans between beams being about 8 ft. The few partitions and those enclosing stairways are of wire lath and plaster. The walls are furred with wire lath with 1″ V-rib stiffeners woven in to offset the wire surface 1″ from the walls. The steel columns are protected by 3″ of gravel concrete rigidly anchored to them. The soffits of the girders and the beams are protected by crimped wire lath and plaster gauged with Portland cement. Roebling wire lath and

PACIFIC STATES TEL. & TEL. CO.'S Main Office, South Side of Bush Street, between Grant Avenue and Kearny Street. The façade of buff terra cotta pressed brick and terra cotta ornamentation is in good condition, there being only a few slight earthquake cracks at the fifth and sixth story levels. All the window openings of this building were protected by metal and metal-covered inside shutters. The fire entered through the only unprotected door opening in the rear at the first-story level, consuming everything that was combustible within, and rendering the fire-proof barriers that had been provided useless, except to prevent draughts. This building was filled with supplies and equipment, producing an intensely hot fire. The Roebling concrete floors and column protection are uninjured. The Roebling wire lath and plaster ceilings and wall furring are in good condition throughout. The wire lath and plaster partitions have buckled out of plumb in some cases. In the roof tier, reinforced concrete beams were employed between the girders. The fire caused the total failure of one of these, and deflected the rest in this tier so that they required renewal. The photograph was taken after the repairs of the roof tier had been started. The steel work throughout is uninjured.

PACIFIC STATES TEL. & TEL. CO.'S Main Office. Fourth Story. Showing the typical condition of the Roebling concrete floors, wire lath and plastered ceilings, wire wall furring and concrete column protection. The photograph was taken after the repair work had started and some of the plaster had been removed. This story was subjected to a severe fire, particularly around the cable rack well in the rear corner. The intense fire at this point spalled the brick wall and caused the failure of the cast-iron and metal tread stairway.

PACIFIC STATES TEL. & TEL. CO.'S Main Office. Showing the partial failure of the reinforced concrete beams supporting the roof, which were damaged by fire. The photograph was taken after the temporary shoring had been put in place.

plaster flat ceilings are erected underneath the floors in all the stories, except the basement.

In the roof tier, the intermediate beams between the girders were omitted and a reinforced concrete beam was substituted, dividing the 16 ft. spans into two. The floor finish throughout is of cement.

The Bush Street front of this building was equipped with Kinnear rolling corrugated outside shutters. The other window openings were fitted with the regular gravity sliding underwriter's inside metal covered shutters. The window frames and sash were metal covered, and the glazing was of wire glass except in the Bush Street front where plate glass was used.

Effects of the Fire and the Earthquake:

The front of the building is in good condition. There are slight earthquake cracks at the fifth and sixth story levels. The west wall has a few earthquake cracks at the sixth and seventh stories. The steel columns in this wall are exposed for several stories in the middle part of the building, where it was in contact with an adjacent building that was destroyed. The east wall is in first-class condition. The levels on the water table indicate that the foundations are level and are evidently in first-class condition. The observations on the walls show that they remain plumb.

After the earthquake, the building was slightly racked, so that it was difficult to close some of the sliding shutters in the upper stories. The fire entered the building through a door in the rear near the southwest corner. There was an immense cable rack in this corner which had recently been installed and equipped, and which produced an intensely hot fire at this point. There was an open well to the roof above the cable rack partially filled with equipment. This well induced a draught, so that the fire was communicated to nearly all of the upper stories immediately. The upper stories of the building were filled with supplies of various kinds in packing boxes, which produced a fire of considerably greater magnitude and intensity than would occur in an office or hotel building.

The reinforced concrete beams of the roof tier were weakened by the heat and deflected badly, one of them failing. The elevator framing is bulged out of line and the cast-iron stairways with metal treads are damaged. The steel frame is uninjured. The concrete arches throughout except the roof tier, which contained the reinforced concrete beams, are in first-class condition. The concrete column protection is uninjured. The wire lath and plaster partitions have buckled out of plumb in many places. The flat wire lath and plaster ceilings remain intact. The wire wall furring is in good condition throughout. The crimped lath and plaster protection of the soffits of the girders and beams is uninjured. The cement floor finish is but slightly damaged. The rolling shutters in the Bush Street front made an excellent showing, preserving the plate-glass glazing. The metal-covered sliding shutters were badly damaged, and only about 50 per cent. of the wire glazing remains in place.

Comments:

It is most unfortunate that the rear door opening at the southwest corner was not protected by some fire-proof barrier. Had that been done, this building would have been extremely interesting, and would, no doubt, have been a practical demonstration of the advantage of protecting the openings. However, the fire was communicated to the interior through this single opening that was unprotected, causing the same damage to the interior that would have resulted had these appliances not been installed. The fire test of the inside shutters was unusually severe, for the reason that a simultaneous fire in the interior exposed both sides of the shutters to attack at the same time.

The damaged reinforced concrete beams in the roof tier will require renewal. The building is otherwise structurally uninjured and can be repaired without difficulty.

Telephone Co.'s East Office.

No. 821 Hyde Street.

Alexander A. Cantin, Architect. Pac. States Tel. and Telegraph Co., Owner.

Details of Construction:

This is a three-story building, known as the East Office and the Hyde Street Station, occupied as an office by the Pacific States Telephone & Telegraph Co. The façade consists of a granite base with buff terra cotta pressed brick and terra cotta ornamentation above. The ornamental cornice is also of terra

PACIFIC STATES TEL. & TEL. CO.'S East Office, 821 Hyde St. The façade consists of a granite base, with buff terra-cotta brick and terra-cotta ornamentation above. The granite base is slightly damaged, but the rest of the front is in good condition. Two cast-iron pillars, at the first-story level, were deflected by the fire, and have been reinforced by new brick piers. This building was subjected to a normal fire only. It is structurally uninjured. The expanded metal concrete floors are only in fair condition, the cinder concrete having been of poor quality originally. The concrete column protection and the floor finish of cement remain in good condition.

PACIFIC STATES TEL. & TEL. CO.'S East Office. Showing the typical condition of the concrete column protection and the damage to the cast plaster ornamental caps. The concrete protection should not have been omitted where the caps were placed. The photograph was taken after repairs had been begun.

cotta. The metal frame is of steel, the walls being bearing walls.

The fire-proof floors are of the expanded metal, flat slab type, of cinder concrete with No. 16, 3″ mesh, expanded metal imbedded in it. The spans are about 7 ft. between beams. The soffits of the beams and girders are protected by expanded metal lath and plaster. The columns are protected with cinder concrete. The floor finish is of cement and terrazzo. The exterior walls are furred with light steel bars at 12″ centres, covered with expanded metal lath and finished in plaster.

Effects of the Fire and the Earthquake:

The granite base of the front is slightly spalled. The terra cotta brick and terra cotta ornaments, as well as the cornice, are in good condition. The cast-iron ornamental pillars of the front, in the first story, failed, and at the time that the building was inspected brick piers had been built adjoining them to support the loads.

There are only slight indications of earthquake damage to the front. The north and west walls of common brick are apparently in good condition, showing only slight earthquake cracks.

This building was subjected to a normal fire only. A falling chimney damaged one span in the roof, and earthquake cracks injured two others, so that they will require renewal.

The concrete column protection remains in good condition. This protection was not carried to the ceiling level, but was omitted where ornamental plaster caps were set. In a number of instances the caps were destroyed, leaving the columns unprotected at those points. The cinder concrete of the floors was originally of poor quality, and many of the spans will require renewal. The cement and terrazzo floor finish is little damaged. The cast-iron stairway, with metal treads, is in fair condition. The exterior metal lath wall furring is intact throughout, most of the plaster still adhering to it.

Comments:

Omitting the column protection where the ornamental caps occurred in this building was a serious defect, and in a severe fire would have caused considerable damage.

Small portions of the walls may require reconstruction on account of earthquake damage. The interior repairs will be comparatively small, and are limited almost exclusively to finish.

Telephone Co.'s South Office.

74-86 West Mission Street.

Alexander A. Cantin, Architect. Pacific States Tel. and Telegraph Co., Owner.

Details of Construction:

This is a three-story building known as the South Office of the Pacific States Telephone and Telegraph Co. The façade consists of gray artificial stone to the water table, buff terra cotta brick to half the height of the first story and white cement plaster finish on common brick above. The walls are bearing walls. The floor and roof loads are carried on steel columns, girders and beams.

The fire-proof floors consist of the Roebling System B or flat slab type of stone concrete, 3½″ in thickness, the spans being about 7½ ft. between beams. The soffits of the beams and girders in the first floor are protected by crimped wire lath and cement plaster. In the upper stories a flat Roebling wire lath and plaster ceiling is erected underneath the floors. The columns are protected by 3″ of cinder concrete anchored to them.

The building had a temporary wood roof over the top story; the design contemplating the addition of several stories later. The floor finish throughout is of cement. The stairways are constructed of solid concrete with steel channel strings.

Effects of the Fire and the Earthquake:

This building was but slightly damaged by the fire, most of the injury sustained by it being caused by the earthquake. The artificial stone base and buff terra cotta brick are practically uninjured. The white cement plaster finish of the upper stories is badly disfigured by earthquake cracks. The south wall at the southwest corner has cracked loose from the west wall, from the top to the bottom. The east and west walls are shaken and racked so that sections of the southeast and northwest corners fell out. Portions of the roof arches being unsupported after the walls fell out, dropped down into a vertical position and are supported by the steel beams adjacent to the walls. The north

PACIFIC STATES TEL. & TEL. CO.'S South Office, 74 and 76 West Mission Street. The façades consist of gray artificial stone to the water table, buff terra cotta brick to half the height of the first story and white cement finish on common brick above. This building had a temporary wood roof supported by the fourth floor, it being intended to increase the height of the building later. The top of the side walls and the parapet walls were overthrown, and portions of the walls were cracked and badly damaged by the earthquake. The two lower stories were provided with metal-covered window frames and sash, with wire glazing, which successfully preserved the contents of these stories. Fire was communicated to the top story through the window openings, which were finished with ordinary wood frames and sash. There was a large amount of expensive equipment and combustible contents in this story, which produced an intensely hot fire. The steel framing and the Roebling concrete floors and column protection remain in first-class condition.

PACIFIC STATES TEL. & TEL. CO.'S South Office. First Story. Showing the condition of the interior, which sustained no fire damage. Note the earthquake cracks and damage to the plaster work in the rear. Everything combustible in the upper story of this building was consumed.

PACIFIC STATES TEL. & TEL. CO.'S South Office. Second Story. The metal covered window frames and sash, with wire glazing, prevented the fire from entering this story. The story immediately above, with unprotected window openings, was subjected to an intensely hot fire without causing the slightest damage to the ceiling or any part of this story. The cable racks, furniture, plastering and cement finished floors were uninjured.

PACIFIC STATES TEL. & TEL. CO.'S South Office. Third Story. Showing the large switchboard, valued at $90,000, totally destroyed. The Roebling concrete column protection, three large skylights, and the suspended wire lath and plaster ceiling are in good condition. The cement floor finish is but slightly damaged.

PACIFIC STATES TEL. & TEL. CO.'S South Office. Third Story. Showing earthquake cracks in the rear wall causing the wall on the left side to move outward. The roof arch adjoining, unsupported, fell into the building to the third floor. The ceiling construction with plaster is hanging to the beam at the right hand side. Part of the burned switchboard is shown in the foreground. The exterior wall wire furring and plaster remain on the rear and left hand walls.

wall is badly cracked, and will require extensive reconstruction. Although the walls were badly damaged, the entire interior was structurally uninjured by the fire. The concrete floors and column protection remain in first-class condition. The concrete steps are unharmed.

Comments:

There was a large property loss in this building. A new switchboard and other equipment costing approximately $90,000 were destroyed in one story alone. The fire was considerably more intense than would ordinarily occur in an office building or hotel, but did practically no damage to the structural steel or the fire-proofing.

The walls of this building were bearing walls and were not rigidly tied together, which no doubt accounts for the damage to them by the earthquake. Large sections of the side walls and almost the entire rear wall will require reconstruction.

Marston Building.

N. E. Cor. Kearny Street and Hardie Place.

Meyer & O'Brien, Architects. Minerva A. Marston, Owner.

Details of Construction:

This is a ten-story store and loft building. The façades consist of cast-iron facias and large glass windows on the first story and buff silica brick and terra cotta ornamentation above. The metal frame consisted of steel columns and girders spaced 14 ft. apart, the walls being self-supporting.

The fire-proof floors are of stone concrete supported by one intermediate reinforced concrete beam between the girders, reducing the spans of the floor slab to about 7 ft. between supports. The concrete floor was reinforced by two light 1″ steel channels, riveted together back to back, at 24″ centres. This building was in the course of construction, the floors having been completed to about the tenth story level. The walls had been built to about the seventh story level.

Effects of the Fire and the Earthquake:

There was considerable scaffolding, a tool house and other combustible material placed on the different floors of this building, which were consumed. In the seventh story, a fire caused by this material damaged one of the floor spans so as to expose the double channel bars at several places.

The terra cotta course on the Kearny Street side, at the fourth story level, is badly spalled and cracked. The terra cotta around the openings of the fourth, fifth and sixth stories is damaged. At the northwest corner, at the fifth story level some of the brick-work has fallen away. The brick wall on the north side of the building has fallen out from the ground up to the fifth floor. At the sixth story level there are earthquake cracks. At the northeast corner, the brick-work has cracked and fallen away at the second and fifth story levels. The east wall was apparently carelessly built, as the wall girders at the fourth and fifth floor levels, where it was in contact with an adjoining wall, were never covered with brick-work and are now exposed.

The levels on the water table show that the foundations remain in good condition. The greatest observed variation of the walls from the plumb is at the southwest corner, where the west wall leans to the west 1½″ in a height of eight stories. The same corner leans to the south about ⅞″.

Comments:

Much of the damage to the exterior of this building was no doubt wrought by the earthquake, but this injury was aggravated later by the fire, so that it is impossible to separate the damage caused by each. The falling away of the north wall and the damage to the brick-work at the corners of the building were no doubt caused by the earthquake.

As the building is in an unfinished condition, and some of the mason work will require renewal, it will be a comparatively easy matter to plumb the building while it is being repaired and finished.

Alto Building.

S. E. Cor. Bush and Kearny Streets.

M. J. Lyon, Architect. Geo. C. Perkins, Owner.

Robert C. Oliphant, Structural Engineer.

Details of Construction:

This was an eight-story office building, approximately 25 ft. x 75 ft. in plan. It was one of the few buildings in San Francisco

that were of strictly steel skeleton construction, with curtain walls.

The fire-proof floors were of the Roebling System B, flat concrete slab type, the spans between beams being about 12 ft. The concrete was of stone. The columns were protected with wire lath and three coats of plaster. The partitions throughout were of the 2″ solid type of wire lath and plaster. The finish of the floors was in wood with sleepers and sleeper fill.

This building was absolutely uninjured by the earthquake. When fire threatened this section of the city, the authorities dynamited it. The effect was to throw it bodily to the northwest, into and across Bush Street. When the fire subsequently swept through this portion of the city, the ruins caught fire and everything combustible in the *débris* was consumed.

Shreve Building.

N. W. Cor. Post Street and Grant Avenue.

Wm. Curlett, Architect. Crocker Hotel Co., Owner.

Details of Construction:

The Shreve Building is an eleven-story office building. The façades consist of gray granite to the height of the water table, cast-iron facias and glass for the first story, and Colusa sandstone above. The ornamental cornice is of metal. The metal frame-work is of steel, the walls being self-supporting.

The fire-proof floors are of the Roebling System B or flat slab type, of stone concrete, the spans between beams being about 6 ft. The columns in the basement, first and second stories are protected with 3″ of concrete by the Roebling method. In the other stories the column protection consists of 3″ hollow tile blocks.

The partitions are built of 4″ hollow tile blocks throughout. The soffits of the beams and girders are protected with crimped lath, plastered with cement mortar. A flat ceiling of Roebling wire lath and plaster was erected underneath all the floors, except in the basement. In the top story there was a level wire lath and plaster ceiling suspended from the roof beams.

The wall furring consisted of Roebling wire lath, with a 1″ deep V furring rib woven in at intervals of about 5″ and finished with three coats of plaster.

The floor finish was in cement, the halls having terrazzo finish, with marble tile borders.

Effects of the Fire and the Earthquake:

The sand-stone of the Post Street front is spalled by the fire around the window openings, the worst damage being done on the west side. On the Grant Avenue side, the entire front is badly spalled by the fire. The ornamental columns at the ninth and tenth story levels are badly damaged. The north front of the building is totally ruined by spalling. The excellent work of anchoring or bonding the veneer to the backing is shown by the fact that in some cases only thin shells of the sand-stone remain in position. The corners of this front, at the east and west sides, are damaged and cracked. The metal cornice is wrecked. The west wall of common brick is in good condition. At the second floor level at the northeast corner is a small crack, the only earthquake crack visible in any of the walls of this building. The entire steel skeleton frame is absolutely uninjured.

The levels on the water table indicate that the foundations are in good condition. The greatest observed variation of the walls from the plumb is at the southeast corner, where the east wall leans to the east about ½″ at the top. At the southwest corner, the south front of the building leans to the south about ⅛″.

The concrete floors and flat wire lath ceilings throughout the building are in first-class condition. The concrete column covering in the basement, first and second stories is uninjured. The hollow tile covering from the third story to the top is considerably damaged, having fallen away in many places. Some of the damage to the tile column protection was caused by bulging pipes. The partitions generally are greatly damaged and a large proportion has fallen down.

The framing of the elevator shaft is bulged out of line. The elevator fronts and cast-iron stairway with metal treads are disrupted and damaged. The cement floor finish is cracked and warped in a few places. The machinery room in the basement is considerably damaged.

Comments:

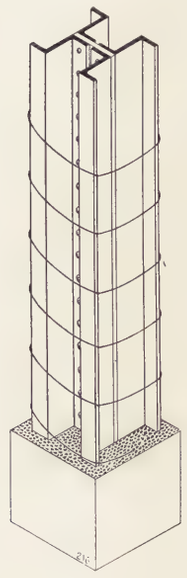
There were a number of wood partitions in the basement, and a great quantity of wood cases for goods stored there by Shreve

SHREVE BUILDING. Showing the Grant Avenue elevation. The façades consist of gray sand-stone. The entire Grant Avenue side is badly spalled by the fire. The ornamental columns at the ninth and tenth story levels are slivered. The metal cornice is wrecked. The Post Street front is spalled around the window openings, the worst damage being on the west side. There is very little earthquake damage. The Roebling concrete floors and wire lath ceilings throughout are uninjured. The Roebling concrete column protection in the basement, first and second stories, is also in first-class condition, but the 3″ hollow tile column protection in the upper stories is considerably damaged, having fallen away in many places. The 4″ hollow tile partitions generally are in bad condition, and a large proportion have fallen down.

SHREVE BUILDING. Second Story. Typical view showing the condition of the Roebling concrete floors, wire lath and plaster ceilings, concrete column protection and 4″ solid concrete and plaster partitions in the rear. The erratic crack in the plastered ceiling in the centre, and the cracks in the concrete partition, were caused by the earthquake.

SHREVE BUILDING. Fifth Story. Showing typical condition of the Roebling concrete floors and wire lath ceilings and of the hollow tile partitions and column covering. The protection of the column on the right has fallen away. The hollow tile partitions were carried to the underside of the concrete floors through the wire lath ceilings, and failed in many places from buckling due to expansion.

& Co., Jewelers, who occupied the basement, first and second floors of the building. The rest of the building was subjected to a normal fire, such as would be expected in a building of this character.



Efficient Concrete Column Protection.

The difference in the efficiency of the two methods of column covering is particularly noticeable in this building. In the three lower stories, where the protection was of concrete, it is entirely uninjured, while in the upper stories, where the protection consisted of 3″ hollow tile blocks, and where the fire was less intense, it was badly damaged and has fallen away in numerous places.

The concrete column protection was anchored to the columns by means of No. 10 gauge galvanized steel wire wound spirally around them at 12 to 14″ centres. The wire is sufficiently stiff to spring away from the plates or flat sides of the column, and affords a key for the concrete between the steel member and the wire. This method of concrete column protection was used also in the main and south offices of the Pacific States T. & T. Co., The California Casket Company's Building and the Hotel St. Francis.

Hotel Hamilton.

South Side of Ellis Street, between Mason and Powell Streets.

David Coleman, Architect. Wm. Helbing, Builder.

Details of Construction:

The Hotel Hamilton is a twelve-story building. The façade consists of sand-stone for the first two stories, sand-stone and terra cotta for the third and fourth stories and terra cotta above. The cornice was of copper. The metal frame is of the steel skeleton type, the walls being curtain walls. The columns are latticed channels covered with wire lath and three coats of plaster.

The fire-proof floors consist of the Collins slotted metal system, being of the flat concrete slab type of cinder concrete 4″ in thickness, the spans being about 14 ft. between girders. The reinforcing metal imbedded in the concrete floor slab consists of about 2″ x ⅛″ flat bars, with sections slotted or cut out and bent at right angles to them. The bars are spaced about 16″ apart and are carried to the structural steel supports and hooked over the top flanges of the beams.

The partitions are of the hollow, double lath and plaster type, the Collins slotted bar being used for the studs, at 16″ centres, and plain wire cloth applied to both sides. A heavy wood sleeper was laid on the floors along the lines of the partitions, to which the studs were fastened. A similar wood strip was fastened to the under side of the concrete floor above to which the studs were nailed at the top. The soffits of the beams were generally along the lines of partitions. When this was not the case, they were protected by plain wire lath and plaster. The floor finish was of wood laid over sleepers and sleeper fill, except the corridors, which had an incombustible finish.

Effects of the Fire and the Earthquake:

The sand-stone in the lower stories is but slightly damaged by the fire, there being a little spalling around the window openings. In the upper stories, the terra cotta is considerably damaged by the fire. The metal cornice is down. The west wall of common brick is apparently in good condition, and has no serious earthquake cracks. The east wall is in fair condition, but the face brick are apparently loose from the backing at the eighth, ninth and tenth story levels.

The levels on the water table indicate that the foundation is not damaged. The greatest observed variation of the walls from the plumb was at the southeast corner, which leans approximately ½″ to the north.

Although the fire in this building was simply normal, and such as would ordinarily be expected to occur in a hotel building, the steel frame is considerably damaged. In the first story, five columns are buckled in the middle portion of the building. In the sixth and seventh stories, a column is buckled west of the elevator shaft. The steel framing around the stairway wells, and the vertical framing of the elevator shaft, are considerably distorted by expansion.

The concrete floors are in good condition throughout. The

HOTEL HAMILTON. South Side of Ellis Street, between Mason and Powell Streets. The façade, consisting of sand-stone and terra cotta, is considerably damaged, and the metal cornice has fallen away. All of the side and rear walls are more or less damaged by earthquake cracks. In the first story five columns are buckled in the middle portion of the building. Two other columns are buckled in the sixth and seventh stories, west of the elevator shaft. The column failures were caused by flimsy and insufficient furring for the wire lath and plaster. The Collins concrete floors are in good condition. The double lath and plaster partitions, with the Collins slotted stud, are in bad condition, on account of the light gauge stud and the wood stringers to which they are fastened top and bottom.

HOTEL HAMILTON. Twelfth Story. Showing a buckled column and the flimsy manner in which it was protected. Only a few light rods were used for the furring and these did not anchor the protection to the column. Note the deflection of the partition due to the settling of the column.

HOTEL HAMILTON. Twelfth Story. Showing the failure of the wire lath and plaster column protection, and the buckling of the partitions due to the settling of the column. The failure of the column protection was caused by the inadequate furring, the lath being simply bent to a rectangular form around the column and attached to the partition in line with the column. Occasionally a ¼″ round rod was used as a support for the lath bracketted from the partitions. In no case was the column protection anchored rigidly to the column.

wire lath and plaster partitions, on account of having a wood sill at the bottom and a wood strip at the top (which were consumed), are loose in many places and in bad condition.

In the first story, where the columns settled by buckling, the partitions are badly warped and deflected. The elevator fronts and the cast-iron stairway with marble treads are badly damaged throughout, and in the first story are completely wrecked. The basement story is much less damaged than any other.

Comments:

The failure of the columns was undoubtedly due to the column protection, which was of very flimsy construction. The furring around the columns to support the lath and plaster was very light and inadequate for the requirements.

The repairs required for the exterior of this building will be comparatively slight. The buckling of the columns referred to has caused the floors throughout the entire building to settle. It may be possible to correct this settling and replace the damaged columns without reconstructing the building, but it will be a difficult and expensive operation.

Hotel Alexander.

North Side of Geary Street, between Powell and Mason Streets.

Moses J. Lyon, Architect. Mrs. Golda Alexander, Owner.

Details of Construction:

This is an eleven-story building, used as an apartment hotel. The façade consists of sand-stone, with cast-iron facias for the first and second story and sand-stone above. The cornice is of copper. The walls are self-supporting and are anchored to the columns in each story, about 850 anchors being used for this purpose.

The fire-proof floor construction is of the Collins slotted metal, flat slab type, similar to that used in the Hotel Hamilton, except that the spans in this building are about 8 ft. between beams.

The partitions are of wire lath and plaster, finishing 2″ thick, the studs consisting of No. 16 gauge metal 1¼″ wide, slotted by the Collins method and placed at 16″ centres. The columns are protected by wire cloth and three coats of plaster. The soffits of the beams and girders are protected by wire lath and plaster flat ceilings throughout, except in the basement, where they are wrapped with wire lath and plastered.

The floor finish is of wood with wood sleepers and sleeper fill.

Effects of the Fire and the Earthquake:

This building was subjected to a normal fire. The front of the building shows no earthquake cracks and is not seriously damaged by the fire. There is considerable spalling around the window openings from the fourth to the eighth story, and also at the eleventh story. The metal cornice is damaged. The east and west walls of common brick are apparently in good condition. The rear wall has been injured in spots by the falling of the wall of an adjacent building.

The levels on the water table indicate that the foundation at the front of the building is level. The greatest observed variation of the walls from the plumb is at the southwest corner, where the south front leans to the south about ¼″.

The entrance hall at the first story is uninjured, and the adjoining store in the first story is only slightly damaged, the greater portion of the wood flooring still remaining in place. The second story of the building is charred in spots, and above this the entire building is fire swept.

A column near the north end of the third story is buckled. On the fifth floor, a column near the elevator shaft is badly buckled. Some of the columns also buckled in the sixth story. In the seventh story, five interior columns are buckled. In the eighth story, one column is buckled in the centre, and in the ninth, one is slightly buckled on the south side. In the tenth story, there are four badly buckled columns.

The concrete floors, notwithstanding the warping of the floor surfaces on account of the buckling of the columns, are in good condition. The wire lath and plaster ceilings are loose and partly down at some places. A lot of brick work from a falling wall back of this building fell through the large window openings in the rear, but did no apparent damage to the concrete floors.

The elevator fronts are badly bulged and damaged throughout. The cast-iron stairway, with marble treads, is considerably injured, and some of the marble treads are broken. The steel

HOTEL ALEXANDER. Geary Street, between Powell and Mason Streets. The façade of sandstone is only slightly damaged by spalling around window openings. The metal cornice has fallen away. Although subjected to only a normal fire, columns have buckled in the third, fifth, sixth, seventh, eighth, ninth and tenth stories, on account of flimsy methods employed in the wire lath and plaster column protection. Notwithstanding the warped condition of the steel work, the Collins concrete floors remain in place and have been very little damaged by the fire. The 2″ wire lath and plaster partitions, with the No. 16 gauge Collins slotted metal studs, are badly deflected and bulged throughout. The illustration shows also a portion of the light court of the Hotel St. Francis which was stripped of the face brick during the fire.

HOTEL ALEXANDER. Buckled column showing the typical method of the furring and lathing for column protection in this building. The light metal furring consisted of No. 16 gauge sheet steel, slotted by the Collins method. Note the excessive buckling and destruction of the furring when such light metal is used for this purpose.

HOTEL ALEXANDER. A buckled column caused by insufficient protection. In many cases the wire lath and plaster partitions enclosing a large blind space around the column were the only fire-proof protection provided. The studs for the partitions in this building were of No. 16 sheet metal, 2½ inches wide, of the Collins slotted metal type. Note the excessive buckling of the light sheet metal due to the heat. The bulging of the pipes adjacent to the column probably contributed to the damage.

window lintels at the front of the building throughout are unprotected, the wood frames being built in contact with them. The wire lath and plaster partition around the stairway was not properly anchored to the steel framing, and is badly sagged and cracked at every story under the stair strings. There was no fire in the basement, and the power plant is but slightly damaged.

Comments:

Although this building was subjected to a moderate fire only, the large number of column failures are no doubt due to the flimsy furring that was used to support the wire lath and plaster protection around them. In several cases where the wire lath and plaster had been broken down by the buckling of the columns it was noted that there were only two ¼″ rod supports for the wire, in a story height, and these supports did not anchor the lath and plaster to the column. They were simply brackets fastened to the partition on both sides of the column, and the wire lath was formed around them.

Except for the buckling of the columns, this building would have been practically uninjured structurally. The replacing of the columns will be an expensive operation, and may involve the reconstruction of a considerable portion of the building. The damage to the exterior is comparatively small.

Merchants' Exchange.

South Side California Street, between Montgomery and Sansome Streets.

D. H. Burnham & Co., Architects. Merchants' Exchange of S. F., Owner.

Details of Construction:

This is a large fourteen-story office building, the lower story at the rear being used as an exchange room by the Merchants' Exchange of San Francisco. It is a well-designed modern building, with a steel skeleton frame and curtain walls, and was completed in 1904. It has a pile foundation. The façade consists of gray granite for the first and second stories and buff terra cotta pressed brick with terra cotta ornamentation above. The cornice is of terra cotta.

The fire-proof floors are of the Roebling System B or flat slab type of cinder concrete, the spans averaging 7 ft. between beams. The soffits of the beams and girders are protected by a flat Roebling wire lath and plaster ceiling throughout, except the first floor, which has a panelled ceiling finish in the basement. The soffits of the beams and girders of this tier are protected with Roebling crimped wire lath and cement plaster.

The column protection throughout is of Roebling wire lath and plaster, double thickness, with an air space between. The corridor partitions are of the Roebling double wire lath and plaster type, finishing 4″ in thickness; the dividing partitions are the single lath and plaster type, finishing 2″ in thickness. The furring on the walls consists of Roebling wire lath with V-shaped ribs, 1″ in depth, woven in and offsetting the wire surface 1″ from the walls.

The floor finish was of wood with wood sleepers and sleeper fill, the halls having a marble tile finish.

Effects of the Fire and the Earthquake:

This building caught fire from adjacent buildings and all the combustible contents of the interior were consumed at the same time that fire was raging in other buildings surrounding it on four sides. It was probably subjected to as severe a fire test as any building of its character in the city.

The granite portions of the front of the building are badly spalled at the second story, but is only slightly damaged at the first story. All the rest of the front is in good condition. The west wall of common brick has some earthquake cracks about midway from the top, and at the southwest corner near the bottom. The east wall of pressed terra cotta brick is spalled in spots from a hot fire of an adjacent building near the front. There are earthquake cracks in the third, fourth, fifth, sixth and seventh stories. A falling wall of a building back of the Merchants' Exchange damaged the rear wall and broke down a portion of the skylight over the exchange room.

The levels on the water table indicate that the foundations remain practically level. The greatest observed variation of the walls from the plumb is at the southeast corner, which leans approximately ⅜″ to the west. The north front at the northwest corner leans to the south only ¼″.

The steel skeleton frame is uninjured, and the building has sustained but very little damage structurally. The double lath

MERCHANTS' EXCHANGE BUILDING. South Side of California Street between Montgomery and Sansome Streets. The façades of gray granite for the first and second stories and buff terra cotta brick with terra cotta ornamentation above, are in good condition, with the exception of the granite, which is badly spalled at the second-story level. The rear walls of common brick are slightly cracked by the earthquake. A falling wall, from a building in the rear, wrecked the skylight and roof over one corner of the exchange room. The steel skeleton frame and the Roebling concrete floors and wire lath and plastered ceilings are uninjured. The double wire lath and plaster column protection is intact. The Roebling wire lath and plaster partitions all remain standing, but are deflected out of plumb in some places. Numerous small vaults and so-called fire-proof safes failed to preserve their contents. This building passed through the earthquake and the fire with as little structural damage as any building in the burned district.

MERCHANTS' EXCHANGE BUILDING. Showing the damage to the exchange room by the earthquake. A section of a six-story building on the opposite side of Liedesdorff Street fell across the street on the roof and skylight of this corner of the room, carrying with it two vaults. One of these fell into the exchange room, and can be seen on the floor at the left hand side. The other is lodged on the roof near the corner of the building amongst other *débris*. Excepting this injury, the exchange room has sustained but little damage.

MERCHANTS' EXCHANGE BUILDING. First Story. Showing condition of Roebling fire-proof floors, partitions, column covering and ornamental lath and plaster ceiling in the banking room of the American National Bank. Everything combustible in this room was consumed, the vaults remaining in good condition. A temporary wood floor was being laid at the time that the photograph was taken.

MERCHANTS' EXCHANGE BUILDING. Third Story. Showing typical condition of the Roebling concrete floors and wire lath and plaster ceilings and partitions. This view was taken immediately after the fire. A small amount of plaster on the floors represents practically all the *débris*.

MERCHANTS' EXCHANGE BUILDING. Typical view showing the condition of the wire lath and plaster ceilings and partitions. The safe in the foreground fell over on its side without doing any damage to the Roebling concrete floor. The vault on the right, enclosed by a solid wire lath and plaster partition 2″ thick, preserved its contents. The contents of a number of other similar vaults in this building were totally destroyed.

MERCHANTS' EXCHANGE BUILDING. Showing a Roebling vault, with double steel doors, which preserved its contents perfectly. The walls and top are of solid concrete; the studs of 2″ x $\frac{1}{8}$″ flat steel are spaced 16″ on centres. Roebling $\frac{1}{4}$″ solid rod stiffened wire lath is applied to both sides of the studs, and the space between the wire surfaces is filled solid with cinder concrete. The plaster is then applied to both sides, making a total thickness of 4 inches. The handles of the combination lock of this vault fused, and it was impossible to open the door. The hole through the wall of the vault in the centre foreground was made in order to get at the contents, and shows the details of the construction. There were no cracks in the walls or top of this vault.

MERCHANTS' EXCHANGE BUILDING. Eighth Story. Showing the buckled and distorted steel supports for mullions. These steel members were rigidly connected top and bottom, no provision having been made for expansion. The buckling and distortion of these members disrupted the terra cotta facing, which fell down breaking the glass and seriously damaging the skylight at the bottom of the light court. The view shows also the distortion of similar steel members on the other side of the court.

and plaster protection of the columns stood well; the outer covering being only slightly damaged in some places, and the inner covering being unaffected.

The concrete floors and wire lath and plaster ceilings are in first-class condition throughout. The lintels over window heads are protected with cinder concrete, which served this purpose well. The lath and plaster partitions remain standing throughout, but in many places are buckled out of plumb. The wire lath wall furring is in good condition.

In the light court, the expansion of the upright steel framing supports disrupted the facing of the mullions, which fell down and broke the glass of the large skylight at the second floor level.

The cast-iron stairways, with marble treads, are in fair condition, but many of the marble treads are broken. The elevator fronts throughout are in fair condition, being bulged slightly at some places.

A number of small vaults that were enclosed by lath and plaster partitions, with steel doors, failed to preserve their contents. The vaults with cinder concrete walls 4″ in thickness withstood the fire perfectly, the contents being in good condition when opened. The combination handles were sometimes fused, necessitating the cutting of holes in the walls to obtain the contents. In some cases, however, the carpenter introduced wood grounds in the spaces to be filled by concrete. The burning of these blocks made openings through which the fire entered and destroyed the contents.

The ornamental work in the main entrance and exchange room is but little injured. The power and mechanical plants in the basement are only slightly damaged.

Comments:

The effect of the fire on small vaults and safes in this building can be assumed to be as severe as is ever likely to occur in a building of this character. In designing receptacles for the preservation of valuable documents, it will therefore be necessary to improve their fire-resisting qualities considerably. In vault construction, the walls should start from the fire-proof flooring and should be of reinforced concrete not less than 4″ in thickness, with a roof covering of the same material and thickness. The door openings should be protected by double barriers, which could be either plain steel doors or metal-covered wood doors hung in solid steel frames and closing against solid metal stops on three sides. The floor finish of such a vault should be of cement or other incombustible material. If the floor finish of the room in which the vault is located is of wood, there should be a border at least a foot wide of incombustible floor finish around the door outside of the vault. If common brick is preferred, an 8″ wall of brick laid in Portland cement mortar could be substituted for the concrete walls, and would probably give equally good results if well tied together with steel rods.

Vast improvements will be necessary in the construction of fire-proof safes, if they are to fulfil the requirements for which they are intended.

The damage to this building by fire is limited almost exclusively to the interior finish and contents. It is to be regretted that a building of such excellent design and good construction did not have its window and door openings protected by metal frames and sash and wire glazing. Had this been done, there is little doubt but that the entire contents of the building would have been saved, and the damage limited to that sustained by the exterior.

This building withstood the effects of the fire and the earthquake admirably and can be repaired without difficulty.

Mercantile Trust Company's Building.

North Side of California Street, between Montgomery and Sansome Streets.

Albert Pissis, Architect. Mercantile Trust Co., Owner.

Details of Construction:

This is a three-story bank building of massive construction. The façade consists of gray granite, the cornice being also of granite. The floors are supported in the interior by steel framing, and the walls are bearing walls.

The fire-proof floors consist of segmental stone concrete arches with light T irons imbedded every 16″. The roof is of the Roebling System B flat slab type, of cinder concrete, 4 inches in thickness, the spans averaging about six to seven feet between the beams.

MERCANTILE TRUST CO.'S BUILDING. North Side of California Street between Montgomery and Sansome Streets. The façade consists of gray granite, which is considerably damaged by spalling around the window openings. The building is structurally uninjured. The fire-proof floors are segmental stone concrete arches. The roof consists of the Roebling system B flat cinder concrete slab. The partitions are of double wire lath and plaster. This building was occupied, pending permanent repairs, a few days after the fire.

The columns are protected by Roebling wire lath and three coats of plaster. The soffits of the girders and the beams are protected by the Roebling wire lath flat ceilings, and ornamental furring and wire lathing, plastered.

The partitions are of the Roebling double wire lath and plaster type. The furring of the exterior walls is of Roebling one inch V-rib wire lath and plaster.

Effects of the Fire and the Earthquake:

The granite front of the building at the second story window openings and the west window opening of the first story, are badly spalled by the fire. Falling *débris* from the adjoining buildings at the time of the earthquake broke holes in the metal frame and wire glass skylight dome over the banking room. The combustible wood finish and furniture made a fire of considerable magnitude in the main banking room. A hot fire also occurred in the third story front room, which was of sufficient intensity to melt the wire glazing in a metal frame skylight in the roof over this room.

The parapet wall on the east side and three small sections of concrete roof construction were broken down by the falling of the brick wall of an adjoining building. The main entrance and the rooms and vaults in the rear are very slightly damaged.

There was no fire in the basement, where the safety deposit vaults are located; the only damage to this story was caused by smoke.

Comments:

This building is structurally uninjured, and the damage to the front and the interior can be repaired.

Kohl or Hayward Building.

N. E. Cor. Montgomery and California Streets.

Geo. W. Percy, H. H. Meyer, Architects. Mrs. Frederick Kohl, Owner.

Details of Construction:

The Kohl Building is an eleven-story office building. The façades consist of Colusa sand-stone, the first story having ornamental cast-iron piers. The building has a steel skeleton frame with curtain walls.

The fire-proof floors are of the expanded metal, flat slab concrete type about 4″ in thickness. 3″ mesh, No. 16 expanded metal is imbedded in the concrete. The spans are about 5 ft. between beams.

The partitions are of double No. 28 gauge expanded metal lath and plaster, the studs being Berger patent No. 20 gauge, 2½″ wide, spaced 16″ apart.

The columns are protected by a double layer of expanded metal lath and plaster with an air space between. The soffits of the beams and girders are protected by metal lath and plaster. The exterior wall furring is of hollow brick of the same size as common brick. All the window frames are of metal, but the sash is of wood, with plain glass glazing.

The floor finish throughout is of cement, and the door frames, doors and trim of the interior are metal covered.

Effects of the Fire and the Earthquake:

The sand-stone front of the building at the second, third and fourth story window openings of the California Street side is considerably damaged by spalling. On the Montgomery Street front the openings from the ground level to the fourth story are also spalled. The upper stories are very little injured, the glazing generally remaining in the windows. The north wall of common brick, with granite ornamentation, is in good condition, the window frames and sash being apparently little damaged by the fire. The east wall is also in good condition.

The levels on the water table would indicate that the foundation remains in good condition. Observations on the walls show that they are practically plumb.

Very little fire entered the basement, and the power plant is practically uninjured. The marble finish of the entrance hall is in good condition, the ornamental plaster ceiling being but slightly damaged. The second and third stories are fire swept, but a few offices in the northeast corner of the building escaped. In the fourth and fifth stories, the fire did the most damage in the offices around the southwest corner of the building. In the sixth and seventh stories the fire entered the building through windows in the northeast corner, consuming all the combustible contents in a few offices and discoloring the rest of the story by smoke. The upper stories are but slightly damaged by fire

KOHL BUILDING. Typical view of the condition of the partitions in the portion of the building damaged by fire. The column protection was of double metal lath and plaster. The partitions were of the 2″ solid metal lath and plaster type, and the doors and all the trim were of metal-covered wood.

KOHL BUILDING. Typical view of the portions damaged by fire. The metal-covered doors, trim, etc., retarded the fire and prevented its spread in many parts of the building. The floors are of the expanded metal concrete type with a cement finish.

KOHL BUILDING. Typical view of the small damage to this building by fire. The concrete floors are finished in cement and are but little damaged in the parts subjected to fire.

and smoke, but are disfigured by a great number of plaster cracks caused by the earthquake.

Comments:

The advantages of the metal-covered trim and the incombustible floor finish were clearly demonstrated in this building. In many cases the fire was confined to the rooms which contained the windows that admitted the fire from the outside. It is to be regretted that the design for protecting the window openings was not complete, and that metal sash with wire glazing were not also provided as well as the metal frames in these openings. Had this been done, fire would never have been admitted to the building, and the entire damage to the interior would have been avoided.

The damage to this building was smaller than that of any of the fire-proof buildings in the burned district. It was uninjured structurally, and many of the tenants occupied it without any inconvenience only a few days after the fire.

Wells-Fargo Building.

N. E. Cor. Mission and Second Streets.

Percy & Hamilton, Architects. Wells-Fargo & Co., Owners.

Details of Construction:

This is a six-story building which was used for offices. The façades consist of granite for the first and second stories, with pressed terra cotta brick and terra cotta ornamentation above. The cornice is also of terra cotta. The metal frame is of steel, the walls being self-supporting. The fire-proof floors are of the concrete flat slab type, with wire fabric of about 4″ x 6″ mesh imbedded in it. Flat wire lath and plaster ceilings are underneath all the floors, except in the basement story, where the soffits of the beams and girders are protected by wire lath and plaster. The partitions are hollow of the double wire lath and plaster type finishing 4″ in thickness. The floor finish was of wood laid over wood sleepers and sleeper fill. The corridors were finished in marble and terrazzo.

Effects of the Fire and the Earthquake:

This building was subjected to a normal fire. The Second Street front remains in good condition, the granite being only slightly spalled around the openings. There is very little earthquake damage on this side. The granite of the Mission Street front is spalled at the second story level. There are characteristic earthquake cracks in the piers of the fourth story, and the terra cotta course at the fifth floor level is also cracked by the earthquake. The terra cotta around the window heads of the sixth story is considerably damaged by spalling. The two rear walls of common brick have also been cracked by the earthquake, but remain in fair condition.

The structural steel is uninjured; the concrete floors are in good condition with the exception of a few spans on the first floor which will require renewal. The wire lath ceilings throughout are in good condition, but the plaster has been badly cracked by the earthquake. The double lath and plaster partitions remain standing, but are slightly buckled out of plumb in some places. The cast-iron and marble tread stairways and elevator fronts are considerably damaged, but can be repaired.

Comments:

The light reinforcing metal used for the concrete floors was not in all cases carefully imbedded in the concrete. A few arches of the first floor sagged on account of the light fabric weakening when heated, and will have to be replaced.

The repairs to the exterior will be comparatively light. The interior repairs will consist almost exclusively of the restoration of the finish.

Hotel St. Francis.

N. W. Cor. Powell and Geary Streets.

Bliss & Faville, Architects. Crocker Hotel Co., Owner.

Mahoney Bros., Contractors.

Details of Construction:

The Hotel St. Francis is a large twelve-story structure facing Union Square. At the time of the earthquake and fire, an addition was partly completed, the steel frame having been erected almost to the roof level and several tiers of concrete floors were in position. The finished portion was completed in 1903.

The façades consist of a granite base with gray sand-stone above. The ornamental cornice is of copper. The metal frame-

WELLS-FARGO BUILDING. Northeast Corner Mission and Second Streets. Showing the Mission Street front. The granite of the two lower stories is considerably spalled by the fire. The terra cotta brick piers at the fourth story level have characteristic earthquake cracks. The terra cotta projecting course at the sixth floor level is considerably cracked, and the window heads of this story are badly spalled. The Second Street front is much less damaged, and is in good condition. The metal frame is uninjured. The concrete floors remain in good condition. The wire lath ceilings remain in place, but the plaster is badly cracked throughout by the earthquake. All the double wire lath and plaster partitions remain standing, but a few of them are out of plumb.

WELLS-FARGO BUILDING. First Story. Showing 4″ hollow metal lath and plaster partitions (with large sash light openings) remaining in position, and the earthquake cracks in the lath and plaster ceiling. The metal lath and plaster column protection is but slightly damaged.

work is of steel, resting on grillage foundations. The fire-proof floors are of the Roebling System A or segmental arch type, with flat wire and lath plaster ceilings underneath, except in the basement story. The floor arches are of stone concrete in the first floor and cinder concrete in the upper floors, the thickness being about 3½″ at the crown and the spans about 7 ft. between beams. The partitions throughout are of 4″ hollow tile blocks, and the exterior wall furring of 1½″ hollow tile blocks. The columns are protected by brick in the basement, by concrete in the dining rooms in the first story and by 4″ hollow tile blocks in the other parts of the building.

The soffits of the beams and girders in the basement story are protected by concrete; in the upper stories by wire lath and plaster.

The floor finish in the corridors and public places is in mosaic and terrazzo with marble borders. In the rest of the building, the finish was in wood laid over sleepers and sleeper fill.

Effects of the Fire and the Earthquake:

The Powell Street front is in good condition, the window openings only being slightly spalled by the fire. The Geary Street front is also in good condition. The metal cornice is completely wrecked. The west light court was entirely stripped of the enamelled face brick from top to bottom by the fire. These brick fell through the skylight at the second floor level into the dining room, the Roebling segmental concrete arches on the first floor withstanding the impact and carrying this enormous load without failure.

There are no apparent cracks in the façades. With the exception of two columns in the mezzanine story, the steel skeleton frame is uninjured. The levels on the water table indicate that there has been no permanent displacement of the foundation. The greatest observed variation of the walls from the plumb was at the southeast and southwest corners, both of which lean to the east about 1″.

The concrete floors, and wire lath and plaster ceilings under them, are intact and in first-class condition throughout. The hollow tile partitions, on account of good mortar and workmanship, are in as good condition in this building as in any in the burned district. The partition blocks over door openings have generally fallen down, and approximately 15 per cent. of all the partitions are down. Large sections of the portions standing have been damaged by the earthquake and the fire, so that they will have to be rebuilt.

The column covering has been damaged in a number of places, but served its purpose sufficiently well to protect the columns, except two in the mezzanine story, which will have to be replaced.

The exterior hollow tile wall furring is only in fair condition, being damaged and loose in spots. The ornamental plaster work in the main entrance and office is badly damaged. The skylights at the second floor level were perforated by falling material that was spalled off around window openings in the light courts. The skylight under the west light court is completely wrecked by the falling of all the face brick in that court while the building was ablaze.

The main stairway of cast iron, with marble treads and base, is considerably damaged throughout. The cast-iron stairway in the southwest corner of the building is in bad condition. The elevator fronts are bulged and damaged throughout. The mechanical and power plant in the basement is also considerably damaged.

Comments:

The good quality of the materials and workmanship show to good advantage in the manner in which this building withstood the earthquake and the fire. With the exception of the two damaged columns in the mezzanine story, it is structurally uninjured. The concrete floors retain their original strength. The repairs of this building will be confined exclusively to the restoration of the slight injury to the exterior and the refinishing of the interior.

California Casket Co.'s Building.

Mission Street, between Fifth and Sixth Streets.

Albert Pissis, Architect. California Casket Co., Owner.

Details of Construction:

This building is seven stories in height. It was just being finished and was unoccupied at the time of the fire. The façade

HOTEL ST. FRANCIS. Northwest Corner Powell and Geary Streets. The façades, consisting of a granite base and gray sand-stone above, are in good condition, a few window openings only being slightly spalled by the fire. The metal cornice is completely wrecked. The west light court was entirely stripped of the enamelled face brick from top to bottom. With the exception of two columns in the mezzanine story, which are deflected out of plumb, the steel skeleton frame is uninjured. The Roebling segmental concrete floors and wire lath and plastered ceilings remain in first-class condition. The Roebling concrete column protection in the large dining rooms is uninjured, but the 4″ hollow tile protection elsewhere is damaged in spots. The 4″ hollow tile partitions are cracked and damaged, and about 15 per cent. of the blocks have fallen down. The good quality of the materials and workmanship have shown to good advantage, this being one of the least injured buildings structurally that passed through the earthquake and the fire. The illustration shows about one-half of the width of the new annex of similar construction.

HOTEL ST. FRANCIS. Interior of the main lobby, looking from the entrance. The ornamental effects were produced by the Roebling method of light steel furring and wire lathing. The plaster caps were cast and are badly damaged. The columns are protected with cinder concrete, a defect in the design showing on the right-hand side where the protection was omitted behind the cap near the top. This portion of the building was subjected to a very moderate fire.

HOTEL ST. FRANCIS. First Story. The fire broke the bond of the face brick of the light court located directly over the centre of one of the dining-rooms, causing the face brick to fall through the skylight to the floor of the dining-room, where they formed a huge pile, as shown. The Roebling segmental concrete arches successfully resisted the impact of the falling brick, sustaining the enormous load without injury until it was removed. The columns in this story were concreted by the Roebling method. Note the mistake of omitting the column protection near the ceiling line, where ornamental plaster caps were placed.

consists of Colusa sand-stone. The walls are self-supporting, the floor loads being supported by a steel frame. The fire-proof floors are the Roebling System B flat slab type of cinder concrete, the soffits of the girders and beams being protected by crimped wire lath and plaster.

The partitions enclosing the stair wells and toilet rooms are of the 2″ solid plaster type. The elevator shaft is enclosed by 4″ hollow wire lath and plaster partitions.

Effects of the Fire and the Earthquake:

There was very little combustible material in this building, and it was practically uninjured by the fire. The damage sustained by it was wrought almost wholly by the earthquake.

The sand-stone front is badly cracked and spalled near the ground level. The east and west corners at the second floor level, and a pier in the fifth story, are also cracked. The cornice of sand-stone is in good condition. The east and west brick walls are cracked at a number of places at the north and south ends. The south wall from the ground level to the fifth story is very badly racked and cracked, the bond between the columns and the brick-work having been broken in a number of places, where the wall has moved away.

The levels on the water table indicate that the northwest corner is about ½″ lower than the northeast corner. The greatest observed variation of the walls from the plumb is at the northeast corner, where the east wall leans to the west 2″. The west wall also leans to the west about 1½″.

A vault about 20 ft. square, enclosed by 13″ brick walls from the floor to the ceiling, was built on the west side in each story. The earthquake completely wrecked the vault on the first floor and caused great cracks in the walls of the vault in the second story. The vaults in the upper stories are also considerably damaged, and some of them will require reconstruction.

The concrete floors in this building are uninjured. The metal work of the partitions is standing, but no plaster had yet been applied.

Comments:

This building has sustained considerable damage by the earthquake. It illustrates the undesirability of having self-supporting walls built around a steel frame, and the structural damage that can result when the bond is broken between the wall and the columns within them. For resisting the effect of earthquakes, the steel skeleton frame principle, by which the walls are supported by steel-work, is much to be preferred. When the walls are not so supported, and are built around the steel frame, they should be very thoroughly and efficiently anchored to the steel members.

The repairs to this building will be confined almost exclusively to the exterior walls and the vaults referred to. Large portions of the rear wall will have to be taken down and rebuilt.

United States Mint.

Fifth and Mission Streets and Mint Avenue.

U. S. Treasury Dept., Architect. United States, Owner.

Details of Construction:

This is a three-story government building of massive construction, occupying an entire block. The streets are comparatively wide and the buildings on the opposite side, facing this building, were generally only two and three stories high. The façades consist of granite for the basement story and limestone for the second and third stories. The ornamental cornice is also of limestone. The walls and footings rest upon pile foundations. The window openings have wood frames and sash with heavy plate-glass glazing. The first and second story openings are fitted with inside folding iron shutters.

The fire-proof floors are of concrete, segmental in form, resting upon corrugated iron centres. The walls are bearing walls. All the partitions consist of thick brick walls. The floors are finished in cement.

Effects of the Fire and the Earthquake:

Except for a few spalled courses of brick on the west side of the south chimney, this building is absolutely unharmed by the earthquake. It was provided with an independent water supply, which was utilized by a large number of troops and employees who fought the fire at the time that this section of the city was burning, and succeeded in preventing any serious

CALIFORNIA CASKET CO.'S BUILDING. Mission Street between Fifth and Sixth Streets. The façade consists of Colusa sandstone. This building was in the course of construction and was only slightly damaged by the fire. The sandstone is spalled and cracked in spots, but the front is comparatively little damaged. The steel skeleton frame and the Roebling concrete floors and column protection are uninjured. The brick vaults, with 13″ walls that were built in each story, were also more or less damaged by the earthquake.

CALIFORNIA CASKET CO.'S BUILDING. First Story. Showing the finished concrete column protection, and the crimped galvanized lath on the soffits of the beams and girders and the exterior wire wall furring ready for the plaster. This building was in the course of construction at the time of the fire and had little combustible contents. All the wood work, such as window frames, scaffolding, etc., was consumed. The merchandise, trestles, etc., shown in the photograph, were carried into the building after the fire.

CALIFORNIA CASKET CO.'S BUILDING. Second Story. Showing the earthquake damage to a brick vault built between the Roebling concrete floors. A similar vault on the first floor was completely destroyed. In the upper stories, the vaults were similarly but less damaged by the earthquake. The Roebling crimped wire is in position on the soffits of the beams and girders ready to receive the cement plaster. The column at the left-hand side is protected with concrete by the Roebling method.

CALIFORNIA CASKET CO.'S BUILDING. Showing typical flight of concrete stairs between steel channel stringers. The crimped wire lath on the soffits of the beams had not yet been covered with cement plaster. The furring brackets at 16″ centres on the wall girders in the stair opening are ready to receive the wire lath.

damage. The fire entered the building in the centre section of the Mint Avenue side, where slight damage was done before it was extinguished. The heat from adjacent burning buildings spalled the limestone of the second and third stories on the north side considerably, but the other three fronts are uninjured. There are no signs of any earthquake cracks in any of the exterior walls.

Comments:

The inside steel shutters and heavy plate glass of this building, and the independent water supply, no doubt contributed largely to the success of the troops and the employees in protecting it. The fact that it occupied an entire block, and was separated by the width of the streets from any other burning buildings, was also of material assistance. The excellent pile foundations and the good workmanship of the exterior walls are no doubt responsible for the successful manner in which this building withstood the effects of the earthquake. Buildings of similar construction in this part of the city, without pile foundations, are almost invariably more or less damaged.

Haas' Candy Factory.

Corner of Mint Avenue and Jesse Street.

Wm. Curlett, Architect. Geo. Haas, Owner.

This was a low building of ordinary construction, the walls being of brick and the floors of wood. A section of the flooring at the ground level, about 20′ x 30′, contained a fire-proof floor of the Roebling System A or segmental arch type, of cinder concrete, the spans between the steel beams being about 6 ft.

This building, as well as the other buildings around it, was completely wrecked by the fire. The west wall of the building, consisting of brick 20″ thick, fell inward upon the concrete floor without breaking any holes in it; the flooring withstood the impact of this enormous load without failure and was still supporting it at the time that the building was inspected.

An examination of the floors on the under side showed that the beams had deflected considerably, but that the concrete arches between them were practically uninjured.

Academy of Science Building.

Market Street, between Fourth and Fifth Streets.

Geo. W. Percy, Architect. California Academy of Science, Owner.

Details of Construction:

This is a six-story building, erected in 1887, that was used as an annex to the main Academy of Science. The latter was a class B building fronting on Market Street, which was dynamited and subsequently totally destroyed by fire. The façade consists of pressed red brick, with red sand-stone ornamentation. The metal frame consists of cast-iron columns with steel girders. The walls are self-supporting.

The fire-proof floors are of the reinforced concrete type and span the interval between girders, which are spaced 12 ft. apart. The concrete is of stone, 9″ in thickness, and is reinforced by ¾″ Ransome square twisted steel bars, spaced 12″ on centres. The plaster is applied directly to the under side of the concrete floor slab.

The floors were finished in wood, laid over sleepers and a 2″ sleeper fill. The cast-iron columns are protected by wire lath and plaster as follows: The wire lath, with ½″ V ribs, was wrapped around the column, the ½″ V ribs offsetting the surface ½″ from the column. Plaster of Paris was then applied to the lath, filling in the space solidly between the wire surface and the column. A solid coat 1½″ thick of plaster of Paris was then applied outside of the wire lath surface.

There are no partitions in the first story of this building. The soffits of the girders are protected by lath and plaster.

Effects of the Fire and the Earthquake:

The sand-stone ornamentation of the entire front is badly spalled. There is a characteristic earthquake crack at the fourth story near the centre. The pressed red brick is in good condition throughout. The north wall is cracked at several places by the earthquake.

This building was subjected to only a moderate fire. Two double reinforced concrete beams in the basement are badly damaged, the concrete having fallen away, exposing six 1″ square section Ransome twisted steel bars. In one bay fourteen consecutive reinforcing bars are exposed in the floor slab.

ACADEMY OF SCIENCE BUILDING. The upper view, taken in the basement story, shows the failure of a reinforced concrete beam. The fire spalled off the concrete on the under side of the beam and exposed six of the 1″ square section Ransome twisted rods. This concrete beam still supports the wall above it, but is badly cracked.

The lower view, taken in the first story, shows fourteen consecutive $\frac{3}{4}$″ square section twisted Ransome rods, which have been exposed by the falling away of the concrete protection under them. Only a moderate fire caused the spalling of the concrete in both cases.

UNITED STATES MINT. Fifth and Mission Streets and Mint Avenue. This building of massive construction occupies an entire block with comparatively wide streets around it. The façades consist of granite for the basement story and limestone above. The foundations rest on piles. It had an independent water supply, and a large number of troops and employees successfully fought the fire when it invaded this section. The window openings throughout were protected by inside steel shutters. Except for a few spalled courses of brick on the west side of the south smokestack, this building was absolutely unharmed by the earthquake. In the centre section of the Mint Avenue side fire entered the building and caused slight damage before it was extinguished. The heat from adjacent burning buildings also spalled the limestone of the second and third stories on the north side.

The concrete floors are generally in good condition. The column protection is intact throughout. At the south side of the building in the first story were located filing cabinets which were full of paper. These made a fire of considerable duration, as is shown by a large quantity of white ashes. The plaster of Paris column protection of the three columns standing among these files is absolutely uninjured.

Comments:

The interesting feature of this building is the column protection. The plaster work of the columns was composed of plaster of Paris instead of the ordinary lime mortar. Plaster of Paris is a well-known non-conductor of heat, and made an excellent showing against the fire in this building. It is, however, not a suitable material for the purpose of protecting structural members, for the reason that it absorbs moisture and is easily abraded and washed away by an ordinary fire stream. Plaster of Paris can, however, be economically and successfully used for column protection, as a filling behind metal column bases or other material which would form a protecting surface against abrasion from a fire stream.

The falling away of the concrete protection under the reinforcing bars of the concrete beams and floor slab in the basement, from the effects of a very moderate fire, has considerable significance. The entire strength of a reinforced concrete beam depends upon the tensile members that are imbedded near its under side. When the protection falls away, and the reinforcing metal is exposed to fire, it is only a matter of a very short time until such small sections of metal become heated to temperatures at which they lose all their strength and failures result.

Grant Building.

S. E. Cor. Seventh and Market Streets.

Newton J. Tharp, Architect. Jos. Grant, Owner.

Details of Construction:

The Grant Building is an eight-story bank and office building resting on pile foundations. The façade consists of red sand-stone for the first story and buff pressed terra cotta brick with sand-stone ornamentation above. The cornice is of sand-stone. The metal frame is of steel, the walls being self-supporting.

The fire-proof floors are of the Roebling System B or flat slab type of cinder concrete (excepting the second floor, which is of stone concrete), the spans between beams being 6½ ft. Underneath all the floors, except the first, a flat Roebling wire lath and plaster ceiling is erected. The partitions and column covering are of 4″ and 3″ hollow tile blocks respectively. The floor finish was of wood on wood sleepers and sleeper fill.

Effects of the Fire and the Earthquake:

The Market Street and Seventh Street fronts are in very good condition, the sand-stone being but slightly spalled by the fire. The bases at the ground level are cracked and spalled. The east wall of common brick is in first-class condition. The south wall of pressed terra cotta brick is considerably damaged and cracked, the two lower stories being in the worst condition.

The levels on the water table indicate that the foundations have not been permanently displaced to any great extent, the corners differing in level less than ¼″. The west wall at the northwest corner leans 1½″ to the east. The north wall leans about ¾″ to the north.

The steel frame of this building is uninjured. The banking room in the first story remains in good condition, having been untouched by the fire. The damage to the plaster work and to the large exterior windows in this room was caused by three heavy charges of dynamite that were exploded in the building on the opposite street corner. The concussion of these explosions no doubt contributed largely to the cracks and damage to the walls of this building. The rest of the building above the first story was fire swept.

The elevator fronts at the different stories are considerably damaged and bulged. The cast-iron stairway with marble treads sustained considerable damage also, a number of the marble treads being broken. The concrete floors and wire lath ceilings throughout remain in first-class condition. The hollow tile column covering is damaged and sections have fallen away in numerous places.

The hollow tile partitions are badly wrecked, most of the blocks having fallen down. In the eighth story, the partitions

GRANT BUILDING. Southeast Corner Seventh and Market Streets. The façades are only slightly damaged, but the rear walls are considerably racked and cracked by the earthquake. The Roebling fire-proof floors and ceilings throughout are in good condition. The 4″ hollow-tile partitions are badly wrecked. The 3″ hollow-tile column covering is damaged and off in many places.

GRANT BUILDING. First Story. Showing the banking room of the Market Street Bank. There was no fire in this room. The damage shown in the photograph was caused by the dynamiting of the Odd Fellows' Building on the opposite side of the street. Roebling concrete floors were used throughout. The column protection and partitions were of hollow tile. The fire consumed everything combustible in the rest of the building.

GRANT BUILDING. Typical view showing the damage to the hollow-tile column protection and the failure of the hollow-tile partitions. The Roebling concrete floors and wire lath and plaster ceilings are in good condition throughout.

GRANT BUILDING. Eighth Story. Showing the damage to the hollow tile partitions and column covering. The partitions were carried through the suspended Roebling wire lath ceiling to the underside of the roof. The falling of the blocks between the ceiling and the roof sagged and damaged the ceiling in many places in this story, as shown. The wire lath ceilings in the other stories remain in first-class condition.

were carried through the hung ceiling to the under side of the roof slab. The portions of the partitions above the wire lath and plaster ceiling were shaken down, and falling on the top of the ceiling, broke it loose from the beams at some places, causing it to sag badly.

Comments:

The mistake of carrying partition blocks through wire lath and plaster ceilings is clearly shown in the upper story of this building. The material served absolutely no useful purpose above the plaster ceiling before the fire, and when the partitions failed they left a slot 4″ wide through which the fire had access to the space between the ceiling and the roof. In addition to this, the falling of the blocks above the ceiling level broke a number of the fastenings, so that large sections of the ceiling will have to be taken down and reconstructed. There being nothing combustible in the space between the suspended wire ceiling and the roof, the heat which entered through the cracks left by the partition blocks was not sufficient to injure the roof framing.

The damage to the walls of this building by the earthquake and dynamite explosions is considerable, and large sections of the south wall will require rebuilding. The repairs of the interior will be limited to the restoration of the partitions, hung ceiling, plaster-work, wood trim and other finish.

United States Post Office.

N. E. Cor. Seventh and Mission Streets.

U. S. Treasury Dept., Architect. U. S. Government, Owner.

Details of Construction:

The United States Post Office is a four-story building, occupies an entire block, and was finished in 1905. The façades consist of gray granite. The metal frame is of steel, the walls being self-supporting. The walls and footings rest on pile foundations.

The fire-proof floors are of the expanded metal, flat slab type, the concrete being of cinder, 4″ in thickness and having No. 0, 3″ mesh expanded metal imbedded in it. The spans between beams will average about 5 ft. The soffits of the beams and girders are protected by Roebling wire lath and plaster ceilings, the wire being laced to the ceiling supports with No. 16 B. & S. gauge copper wire.

The doors and the window frames and sash are of wood. The floor finish is of wood, except the halls and public spaces, which are finished in mosaic.

Effects of the Fire and the Earthquake:

The front of the north side has extensive earthquake cracks, the granite facing of the east front is cracked loose from the backing and is temporarily braced at several places. The southeast corner is racked and a window head has one ring stone of the arch out and others loose. At the southwest corner, the ground settled about 2 ft. at the building line and about 5 ft. at the curb, the entire surface from the building line moving out about 5 ft. to the south. This distorted the sidewalk and steps of the two entrances, there being cracks in the joints of the cement sidewalk slabs 8″ wide. It was necessary to place two temporary wooden steps of about 8″ rise from the sidewalk in its settled position to that portion of the steps which remain approximately at the original height.

The granite base at the sidewalk level and some of the granite ornamental railing is spalled in spots by the burning of bundles, trunks and other personal property deposited against it by refugees.

The levels on the foundations indicate that the northeast and southeast corners remain practically level, the northwest corner being about 6/10″ higher and the southwest corner about 2 1/8″ lower, respectively. The plumbing of the walls indicates that they are very little out of plumb. At the northeast corner, the east wall leans to the east about 1″.

This building was protected by troops and employees while the fire was burning in this section. Fire entered the building only at the northeast corner in the third story. The window head at this point is considerably spalled by the fire and the combustible finish of one large room was destroyed before the fire was extinguished. Although the fire in this room was only of moderate intensity, it was sufficient to heat the copper wire with which the wire lath ceiling was laced to the supports, so as to weaken it sufficiently to allow the wire lath and plaster to fall

UNITED STATES POST OFFICE. Northeast Corner of Seventh and Mission Streets. At the curb in front of the building, on the right-hand side, the ground settled 5 feet and moved to the east away from the building about 6 feet. At the building line, the ground settled about 2 feet, causing the displacement of the granite coping, steps, etc., at the sidewalk level, as shown. The sidewalk was originally a straight grade on the right-hand side where the sag is now shown. The northwest corner of the building was badly racked by the earthquake, and temporary shores were in position when the photograph was taken. This building was only slightly damaged by the fire.

UNITED STATES POST OFFICE. Northeast corner Seventh and Madison Streets. Showing the earthquake damage at the northwest corner of the building. Also showing the window at the third story level through which the fire entered one of the rooms. This was the only portion of the building damaged by fire. Troops and employees successfully fought the fire and prevented it from doing material damage. There was originally a creek at the present location of the Post Office, rendering the conditions especially difficult for providing a stable foundation.

away from the furring supports. The clips by which the furring was attached to the beams were also of poor design.

Comments:

Much of the facing of granite in the walls of this building is damaged and cracked, and will have to be taken down and rebuilt over considerable areas. The spalling of the granite from the effect of so insignificant a fire as the burning of trunks and parcels of clothing indicates how easily granite can be damaged by fire. This building should have been equipped with metal window frames and sash and wire glazing, or some form of efficient fire-resisting shutters.

Hibernia Savings and Loan Society Building.

N. W. Cor. McAllister and Jones Streets.

Albert Pissis, Architect. Hibernia Savings and Loan Society, Owner.

Details of Construction:

This is a two-story bank building of massive construction. The façades are of gray granite. The floors are supported by steel framing, the walls being bearing walls.

The fire-proof floors are of ordinary rowlock segmental brick arches in the old portion of the building, and plain segmental stone concrete arches in the new portion. The ceilings and ornamental work are of Roebling wire lath and plaster. The floor finish is of wood on wood sleepers, with cinder concrete filling between the arches and the wood floor finish. In the halls and public spaces the floor finish is incombustible.

Effects of the Fire and the Earthquake:

The window heads in the middle portion of the McAllister Street front are much spalled by the fire from the interior. The entire Jones Street side is badly damaged and spalled by heat from the burning buildings on the opposite side of the street. There are no perceptible earthquake cracks in the façades. The north wall is in good condition. In the west wall, the granite work is badly spalled from the heat of adjoining buildings. The window heads are also badly spalled by the fire from within.

The ornamental plaster work of the main banking room is little injured, except around the skylight.

The fire-proof floors remain in good condition throughout.

Comments:

This building sustained very little structural damage. The Jones Street façade was ruined by the burning of buildings on the opposite side of the street, and will require complete renewal. The McAllister Street front, and the damage to the north and west sides, can be repaired. The repairs to the interior will consist of plaster work and finish.

Colonial Theatre.

South Side of Market, between Seventh and Eighth Streets

Chas. Haynes, Architect. Geo. A. Story, Owner.

Details of Construction:

This building was in the course of construction and nearly completed. It has a cementine or imitation stone front. The auditorium floor rests directly on the ground. The brick walls have concrete foundations, which extend five feet below the street level and are carried to a height of seven feet above it.

The roof is supported by light steel trusses and framing covered with galvanized iron. An ornamental ceiling of light steel furring and expanded metal is erected under the roof.

Effects of the Fire and the Earthquake:

There was no fire in this building, the slight damage to it being wrought solely by the earthquake. The brick-work at the southwest corner above the concrete is considerably racked, and some of it is shaken down. The east wall of the rear extension above the concrete is also cracked from the top down to the concrete foundation. The brick wall at the northwest corner of the rear extension is damaged and a portion has fallen down.

Comments:

The construction of this building is interesting on account of the very heavy, continuous concrete foundation which supports the low brick walls. A careful examination of the concrete work did not disclose any cracks or other damage by the earthquake.

HIBERNIA SAVINGS & LOAN SOCIETY BUILDING. The façades of gray granite are considerably injured. The window heads in the middle portion of the McAllister Street front are badly spalled by fire from the interior. The entire Jones Street side is scaled and spalled by heat from burning buildings on the opposite side of the street. There is little earthquake damage. The segmental brick and concrete floor arches and the wire lath ceilings remain in good condition. The Roebling ornamental furring and lathing work is uninjured, but the plaster finish is damaged by earthquake cracks and smoke.

Majestic Theatre.

S. E. Cor. Ninth and Market Streets.

Wm. Curlett, Architect. Wm. Ede Co., Owner.

Details of Construction:

The Majestic was one of the most recently completed theatre buildings in San Francisco. It had an entrance by an arcade from Market Street through a class B building which was destroyed by the fire. The exterior walls are bearing walls and are of common brick. Terra cotta ornamentation was used around the door and window openings.

The floors and interior loads were supported by a steel frame. The roof was carried on large trusses, the spans being about 75 ft. between the walls. These trusses were supported on plates resting on brick walls 17″ thick, reinforced by pilasters 8″ thick on the outside and 4″ thick on the inside, the bases of the trusses being about 80 ft. above the ground level.

The fire-proof floors are of the Roebling System B, flat slab type of cinder concrete 4″ thick, the spans between beams being 5½ ft. The soffits of the beams and girders were protected by wire lath and plaster.

Effects of the Fire and the Earthquake:

This building was wrecked by the earthquake, and later all the combustible contents were consumed by fire.

The entire west wall fell out at the top, causing the roof of the stage and everything under it to fall to the first floor. The top section of the north gable wall was shaken down.

The east wall is down on the south side. A large section under one of the roof trusses is cracked loose from the east wall, and has moved about 4″ laterally, as is shown by the pilaster on the outside, which is about 4″ out of line at the fracture.

A large section of the ornamental lath and plaster ceiling over the auditorium is still in position under the remaining portion of the roof. All the combustible finish and furniture of the auditorium, balcony and gallery have been consumed, the metal work of the seats and the concrete floors only remaining. In the portions of the building that have not collapsed the steel framing and the concrete floors remain in first-class condition.

Comments:

The walls are completely wrecked and sections supporting the roof trusses were dangerous at the time the building was inspected. A very slight tremor would no doubt cause the truss on the south side to fall.

The inadvisability and danger of carrying large trusses on bearing walls at a great height, as was done in this case, is clearly shown. Steel columns should be provided and the trusses rigidly connected to them and braced.

It is probable that the entire building will require demolition and reconstruction.

United States Sub-Treasury.

Commercial Street, between Montgomery and Clay Streets.

U. S. Treasury Department, Architect. U. S. Government, Owner.

Details of Construction:

This is an old four-story building. The façade consists of pressed red brick with granite ornamentation. The roof arches are of concrete on corrugated sheet metal centres, the soffits of the beams remaining exposed. The floors were of heavy wood construction. The windows of the first story are protected by rolling steel shutters.

Effects of the Fire and the Earthquake:

The front of this building remains in good condition. The roof over the centre section of the building failed and fell into the light well in the central portion of the building. The rest of the roof arches appear to be in good condition. The wood floors and the combustible contents were consumed by the fire.

Comments:

This building was guarded by United States troops, and a detailed examination of the interior could not be made.

Monadnock Building.

South Side of Market Street, between New Montgomery and Third Streets.

Meyer & O'Brien, Architects. Herbert E. Law, Owner.

Details of Construction:

The Monadnock Building is a ten-story structure which is in the course of construction, and is intended for an office building.

MAJESTIC THEATRE. Northeast Corner Ninth and Market Streets. This building had an entrance by an arcade from Market Street through a Class B building, which was destroyed by the fire. All the walls are bearing walls and of common brick with terra-cotta ornamentation. The left-hand side is the stage portion of the building, and was totally wrecked by the earthquake. The gable wall at the opposite end of the building was also shaken out, large portions of the brickwork falling upon the gallery tier and being supported by it. Roebling concrete floors and ornamental furring and lathing were used throughout. Note the floating section of brick wall cracked loose and supporting a large truss of 75 feet span, about 80 feet above the ground. The loose section of the wall has moved horizontally so that the side of the pilaster is 4 inches out of line.

MAJESTIC THEATRE. Southeast Corner Ninth and Market Streets. Showing the interior, looking toward the auditorium. The wall in the rear, above the gallery, was shaken down by the earthquake. Everything combustible in the auditorium was consumed, leaving only the castings of the seats in position. The ornamental ceiling over the auditorium, of wire lath and plaster, is still in place between the wrecked portions of the roof. Note the enormous load of brick from the rear wall which fell on the gallery tier, and is supported by it. Roebling fire-proof floors with a cement top finish were installed throughout and are in good condition.

The wall on the west side of the building had not been built at the time of the fire, this portion of the building being incomplete on account of delays in negotiations for adjacent property. The Market Street façade consists of gray sand-stone for the first and second stories, terra cotta brick from the third to the eighth story inclusive and terra cotta for the ninth and tenth stories. The ornamental cornice is of metal. The interior light court is faced with vitrified brick with terra cotta ornamentation. This building has a steel skeleton frame, the walls being curtain walls.

The columns support girders spaced about 16 ft. apart, and the floor construction spanning the interval between the girders is of the reinforced concrete type. Reinforced concrete beams divide the girder spans in two, making the spans of the concrete floor slab between supports about 8 ft. The tension members of the reinforced concrete beams consist generally of four ½″ square section Johnson bars. No. 10, 3″ mesh expanded metal is imbedded in the floor slab, which is about 3½″ in thickness, and of stone concrete.

A flat ceiling of expanded metal lath and plaster is erected underneath the floors in all the stories above the basement. The soffits of the beams and girders of the ground floor are protected with expanded metal lath and plaster.

The partitions throughout are of the double, hollow expanded metal lath and plaster type. The columns are protected by a double thickness of expanded metal lath and plaster. The floor finish is of wood laid on wood sleepers and sleeper fill.

Effects of the Fire and the Earthquake:

The fire in this building was comparatively light, some sections escaping without damage. The front of the building is but little injured by the fire, the sand-stone being only slightly spalled at the corners. The terra cotta piers between windows are badly racked by the earthquake, and show characteristic X cracks quite generally from the third to the eighth story. The corner on the east side is badly damaged. The terra cotta of the top stories appears to be in good condition. The bond of the face brick of the east wall is broken over considerable areas, and one section near the south side, 30 ft. wide and 40 ft. high, has fallen away. The south wall, with terra cotta brick facing, is in fair condition. The cornice at the west side is down. The terra cotta ornamentation in the light court is slightly spalled, and the parapet wall on the west side has been shaken down by the earthquake.

The plumbing of the walls shows that the greatest variation from the plumb is at the northwest corner where the Market Street front leans to the south about ⅞″. It was impossible to find corresponding points at the different corners of this building to level the foundations.

In the basement story where the column protection had not yet been placed, a pile of lumber for scaffolding caused the buckling of two columns and the deflection of some steel beams and girders that were exposed. A charge of dynamite on the west side of this building disrupted an entire bay between four columns of the first floor, breaking the connections of the beams and girders at the columns and causing the entire floor section to drop to the basement. The wire lath and plaster ceiling of the third story, immediately above this bay, was also destroyed, portions hanging in shreds by the original fastenings. Three reinforced concrete beams adjacent to the bay that was destroyed by dynamite, are badly shattered. The steel girders and concrete protection around them, which support the reinforced concrete beams, although nearer to the disrupted bay, are uninjured. The dynamiting also caused considerable damage to other portions of the work on this side of the building.

Except the damage referred to, the steel skeleton frame and the concrete floors and ceiling are in good condition throughout the building. Those portions of the building that escaped the fire are considerably damaged by earthquake cracks in the plaster work and other finish. The cast-iron elevator fronts and stairways remain in good condition.

Comments:

It was noted that the columns were left exposed back of the marble wainscoting in the hallways in several instances where the wainscoting had failed and fallen away from the partitions. If the column protection was omitted throughout in these locations, serious damage would have resulted to the columns had this building been subjected to a fire of normal intensity and duration.

MONADNOCK BUILDING. First Floor. Showing the effect of dynamiting. One complete bay was entirely disrupted, the steel connections of the beams and girders being broken, allowing the mass to fall into the basement and wrecking the expanded metal lath and plaster ceiling of the floor directly above it.

MONADNOCK BUILDING. Basement Story. Showing buckled columns caused by the burning of scaffolding lumber piled around them. The bay of floor construction standing on edge in the centre was broken out by dynamite. The building was in the course of construction, and the protection of the columns had not yet been placed.

MONADNOCK BUILDING. Basement Story. Showing the damage to reinforced concrete beams adjacent to the bay that was disrupted by dynamite.

MONADNOCK BUILDING. Basement Story. Showing the failure of reinforced concrete beams and flooring near the southwest corner of the building. The other ends of the reinforced concrete beams in the foreground are supported by a girder adjacent to the bay which was blown out by dynamite. Whether caused by dynamiting or by earthquake, the damage to the floors would probably have been much less had steel beams been used.

The damage to all the exterior walls of this building is considerable, and large sections will have to be rebuilt.

Ruef Building.

Junction of Montgomery Avenue and Kearny Street.
Salfield & Kohlberg, Architects. Abe Ruef, Owner.

Details of Construction:

This is an eight-story building that was in the course of construction at the time of the fire. The steel skeleton frame and the fire-proof floors, which are of the Roebling system B or flat slab type of stone concrete, are completed. The brick wall on the south side has been built up to the sixth floor. None of the other walls has been carried above the ground level.

Effects of the Fire and the Earthquake:

This building contained little of a combustible character, and was only subjected to the heat of the surrounding buildings which were destroyed by the fire.

The levels on the foundations show that they remain in good condition. Observations on the steel skeleton frame show that the south face at the southwest corner is plumb from the ground to the fourth floor. From the fourth floor to the top, the south front leans to the south at this corner 1½″.

Comments:

The damage to this building is apparently very small, and consists principally of the slight departure from the plumb of the upper portion of the building. There will be no serious difficulty in correcting this and finishing the building.

United States Appraisers Building.

Sansome, Clay, Washington and Battery Streets.
U. S. Treasury Department, Architect. United States Government, Owner.

This is a four-story Government building that is used as a warehouse. The façades consist of pressed red brick with granite ornamentation. The ornamental cornice is of metal. None of the walls shows any earthquake cracks. The windows have ordinary wood frames and sash, but the glazing is of ¼″ plate glass. The building is not equipped with fire-proof shutters.

This building was surrounded on three sides by streets, and on the east by a narrow alley and the new court-house site. At the time that the fire was raging in this section of the city, a large force of troops assisted in fighting the fire, and succeeded in preventing it from entering the building.

Spreckels Annex Building.

Market Street, West of Third Street.
Reid Bros., Architects. Claus Spreckels, Owner.

Details of Construction:

This is a five-story store and office building adjoining the Claus Spreckels Building. The façades consist of gray sand-stone and cast-iron facias for the first story and sand-stone for the upper stories and the cornice. The metal frame is of steel, the walls being self-supporting.

The fire-proof floors are of cinder concrete, segmental in form, the spans between the beams being about 8 feet. Underneath the concrete floors throughout, except in the basement story, a flat, expanded metal lath and plaster ceiling is erected.

In the first story, the partitions of the entrance hall and the stairway enclosure are of 6″ hollow tile blocks. Above the first story, the enclosing partitions are of expanded metal lath and plaster. The columns are protected by furring and metal lathing, covered with three coats of plaster. The floor finish was of wood laid on wood sleepers and sleeper fill.

The walls of the light court between this building and the Spreckels Building consisted of 6″ hollow tile blocks with a white enamelled face.

Effects of the Fire and the Earthquake:

The upper story and cornice of the front have fallen down. The rest of the sand-stone front is slightly spalled around the window openings by the fire, but is otherwise in good condition. The roof was supported on light star section columns, consisting of 4 angles. The hollow tile protection around these columns in the walls of the light court failed, causing the columns to buckle and the entire east side of the roof to fall to the fifth

RUEF BUILDING. Junction Montgomery Avenue and Kearny Street. This building was in course of construction, with the steel frame and fire-proof floors completed. Only a portion of the rear brick wall has been carried to the sixth story. The Roebling fire-proof floors and the steel frame are uninjured. This building sustained no serious structural damage from the earthquake or the burning of adjacent buildings.

floor. In the fourth story, two steel wall columns in the front are badly deflected by the heat. The expanded metal partitions enclosing the stairway and elevator shaft in the upper stories are standing, but are badly distorted. The 6″ hollow tile partitions in the first story are wrecked, most of the blocks having fallen down. The elevator fronts and cast-iron stairway, with metal treads, are greatly damaged throughout.

Comments:

This building was subjected to a normal fire. The failure of the small columns in the walls of the light court, which was constructed of hollow tile blocks, caused the wreck of the roof and practically all the damage to the upper part of the building.

Hall of Justice.

S. E. Cor. Kearny and Washington Streets.

Shea & Shea, Architects. City and County of San Francisco, Owner.

Details of Construction:

The Hall of Justice is a four-story building that was occupied by various city legal departments. It has an ornamental tower projecting three stories above the main portion of the building. The façades consist of Colusa sand-stone for the first story and buff terra cotta brick and terra cotta ornamentation above. The cornice is of metal. The building has a steel frame with Z-bar section columns, the walls being self-supporting.

The fire-proof floors are of the expanded metal suspender system type, similar to the floors described in detail in the Young Building, except that the suspender bands are of 4″ x ¼″ metal. The spans between supports are 20 ft., the suspender ribs being spaced about 4 ft. centres. The concrete floor slab is of cinder, about 4″ in thickness and has imbedded in it No. 16, 3″ mesh, expanded metal.

The columns are protected by light steel furring and expanded metal, finished with three coats of plaster. The soffits of the beams and girders are also protected by expanded metal lath and plaster. The partitions are hollow, of the double expanded metal lath and plaster type. The dome is constructed of very light steel framing and covered with galvanized iron.

The floor finish was of wood on sleepers and sleeper fill, except the corridors, which had an incombustible finish. The roof was water-proofed with tar and gravel.

Effects of the Fire and the Earthquake:

The sand-stone of the façades is slightly spalled in the first story, principally around the window heads and the small cornice above. The terra cotta ornamentation of the upper stories is also spalled. The galvanized iron cornice is damaged in the middle portion of the Kearny Street front. The ornamental balustrade parapet on the roof is wrecked. The earthquake did little damage to the main part of the building, but the tower was badly racked and almost completely wrecked by it. Both side walls and the rear wall of the first story of the tower were shaken down by the earthquake.

Fire entered the ornamental tower, and by heating the light, unprotected framework, weakened it and caused the dome to fall over in a southerly direction, overhanging the tower on the east side, with the flagpole almost in a horizontal position.

The entire rear half of the building, comprising an area of approximately 30 x 90 ft., has collapsed and fallen into the basement. The roof of the roof houses having been of wood construction burned off, completely wrecking these light structures, which contained prisoners' cells.

In the engine-room in the sub-basement one column is buckled. Two columns are badly buckled at the floor level in the basement. In the first story the same columns are also slightly buckled, and a girder at the left of the main entrance is bulged out of line. In the third story, the 7″ I beam columns at the angles of the light well are badly buckled by the heat.

The elevator fronts and framing, and the cast-iron stairs and treads, are much damaged throughout.

Excepting the buckled columns that have been referred to and the wrecked section of the building, the steel work remains in good condition. The concrete floors with the exposed suspender bands are protected throughout by a flat expanded metal lath and plaster ceiling, which remains in fair condition and prevented the excessive deflection of the concrete floors, which otherwise would have resulted.

Comments:

The wreck of the rear part of the building was, no doubt,

HALL OF JUSTICE. S. E. Cor. Kearny and Washington Sts. The façades consist of Colusa sandstone for the first story, and buff terra cotta brick and terra cotta ornaments above. The front of the building, excepting the tower, cornice and balustrade parapet, is but slightly damaged. The entire rear portion of the building and the tower are wrecked. The dome over the tower was of light steel framing, covered with galvanized iron. When fire entered the tower, the light steel members quickly failed, causing the dome portion to fall over in a horizontal position. Most of the damage to the mason work of the tower was caused by the earthquake.

HALL OF JUSTICE. From the alley at the rear, looking into the rear half of the building which was wrecked. The suspender system of expanded metal floors was used in this building. This view shows the partial failure and sagging of the first floor arches under a heavy overburden of *débris*. In the upper stories the suspender bands are hanging in a vertical position from the parts of the building that remain standing. The rear wall was only 8″ thick between pilasters and was about 60 feet high. Lime mortar of poor quality was used in this building.

HALL OF JUSTICE. Basement Story. Showing a buckled column in the foreground, with disrupted expanded metal lath and plaster protection still adhering to it. This view was taken in the property room, showing stolen goods that were to be used as evidence in cases against prisoners. The prisoners' cells were located in the top story. The ceilings and partitions are of expanded metal lath and plaster.

caused by the failure of one or more of the large trusses supporting the roof. The wood roof over the roof houses, and other wood-work around the cornice and the upper portion of the building, no doubt, contributed to the heat which caused the failure of these trusses.

It was noted that the rear wall between pilasters was only 8″ thick for a height of about 50 ft. Much less damage would have resulted had this been a steel skeleton frame building, with the walls supported by the steel work.

While the front is but slightly damaged, the wreck of the rear portion and the tower is so extensive that in all probability the building will require total reconstruction.

Turkish Baths.

No. 632 Post Street.

Wm. Helbing, Architect and Builder. Robert C. Oliphant, Structural Engineer.

Details of Construction:

This is a seven-story building equipped for baths. It has an ornamental façade of cream-colored terra cotta. The cornice is of metal. The metal frame is of steel skeleton construction, the walls being curtain walls.

The fire-proof floors are of cinder concrete with ½″ square section, twisted Ransome bars imbedded in it at 12″ centres. The spans are 5 to 10 ft. between beams. Underneath the floors, and protecting the soffits of the beams and girders, is a flat wire lath and plaster ceiling. The partitions are of the 2″ solid wire lath and plaster type.

The columns are protected with wire lath and three coats of plaster. The floors were finished in wood over sleepers and sleeper fill. The hallway floors are finished in mosaic. A reinforced concrete stairway supported by 5″ diameter wrought-iron pipe columns is near the front at the east side. The bay windows were of wood construction.

Effects of the Fire and the Earthquake:

Excepting the southwest corner, which is badly cracked and spalled, the terra cotta front is but slightly damaged. There are a few earthquake cracks visible. The north wall of concrete and buff terra cotta brick is in fair condition, being slightly cracked by the earthquake. The west wall is also in fairly good condition, except the southwest corner, where the terra cotta veneering is spalled and has fallen away in spots.

This building had not yet been occupied, and was subjected to a moderate fire only. In the lower story, where the bathing pools are located and where the floor finish was of incombustible material, there is comparatively little damage, most of the wood trim remaining. The entire building above this story was fire swept.

In the second story there is a buckled column near the centre of the building. On the east side are outside tie beams crossing the light well. These have been considerably buckled and deflected by the heat.

The concrete floors throughout are in good condition. The wire lath ceilings under them are loose in spots, but remain generally in position. The lath and plaster partitions, on account of being built against wood plates in the ceiling, are in bad condition, being loose and bulged out of plumb quite generally.

The column protection was not first-class and failed to prevent the buckling of a column in the second story. The concrete stairway is uninjured, but some of the wrought-iron pipe supports are slightly deflected.

Comments:

The tie beams across the light court in this building were exposed and were damaged by the heat from the fire of adjoining buildings. Structural ties of this character are very generally used and are frequently left exposed. The expansion of such members no doubt causes abnormal stresses before the steel becomes sufficiently heated to buckle or deflect. Such consequences should be avoided by suitable protection. Their exposure to the weather in positions where they are usually inaccessible for painting, is also injurious, and consequently objectionable.

The partitions in this building were carried through the wire lath ceilings to a wood plate that was attached to the floor beams above. This is exceedingly bad practice, since the plate attached to the floor beams ignited in many places and

TURKISH BATHS. 632 Post Street. Excepting the southwest corner, which is badly cracked and spalled, the terra-cotta façade is but slightly damaged. A few earthquake cracks are visible in all the walls. There is a buckled column in the second story near the centre of the building. The bay windows were of wood construction. The cinder concrete floors remain in good condition. The metal lath and plaster ceilings, partitions and column covering are considerably damaged, but remain in position.

caused more or less additional heat in the blind space between the ceiling and the under side of the floor arches.

The repairs to the exterior of this building will be comparatively light. The replacing of the buckled column should not be a very serious matter. The rest of the repairs are limited to the restoration of the interior finish.

Storage Warehouse.

West Mission St., East of Thirteenth Street.

Ralph Hart, Architect. Bekins Van and Storage Co., Owner.

This building was in the course of construction. The exterior walls are bearing walls and are of brick laid in lime mortar. The interior columns, girders and beams are of reinforced concrete. The floor slab is reinforced by ½″ square, twisted Ransome rods at 12″ centres. The walls of this building had been carried up two stories, and the second tier of reinforced concrete was being placed.

The brick walls are considerably damaged by the earthquake, being badly cracked at the corners and having a number of small cracks running from the ground to the second story. Part of the front wall at the top has fallen away.

In the southwest corner of the building, near the entrance, a pile of furniture and other personal property belonging to refugees caught fire, producing sufficient heat to spall off the stone concrete underneath the reinforcing metal, exposing a number of the bars in the floor slab and in one of the reinforced concrete beams.

This is another instance where a comparatively light fire has caused the falling away of the concrete protecting the metal tensile members of reinforced concrete.

Fairmont Hotel.

Powell, Sacramento, Mason and California Streets.

Reid Bros., Architects. Law Bros., Owners.

Details of Construction:

The Fairmont Hotel is a handsome, conspicuous, six-story building crowning Nob Hill. The façades consist of gray granite for the first story and cream terra cotta above, including the cornice. The metal frame is of steel, the walls being self-supporting.

The fire-proof floors are of the expanded metal, flat slab type, of cinder concrete, the spans between the beams averaging about 7 ft. The soffits of the girders and beams are protected by a flat expanded metal lath and plaster ceiling. The columns are protected by expanded metal lath and three coats of plaster. The partitions throughout are of the 4″ hollow expanded metal lath and plaster. The wall furring consists of light steel studding at 12″ centres covered with expanded metal lath and plastered with three coats. The floors were finished in wood on wood sleepers and sleeper fill, except the hallways and public spaces, which had an incombustible finish.

Effects of the Fire and the Earthquake:

On the Mason Street front the window heads of the first story, north of the entrance, are very badly spalled by the fire. The terra cotta above is but little injured. The small cornice over the main entrance is also damaged by heat. The main cornice of the building, however, is little injured. There are only a few almost imperceptible earthquake cracks on this side. The surface of the concrete below the first floor level on the California Street side is unfinished. The granite of the first story is in good condition. The terra cotta at the second story level of the end projections is very badly racked and splintered by the earthquake. The upper portion of this façade remains in good condition.

On the east side are two low annexes or wings at each end of the building. These have concrete bases which are but little damaged, there being a few earthquake cracks at the corners. The granite of the first story on this side is in good condition. At the second story level, however, the terra cotta surfaces between window openings are racked and cracked almost across the entire width of the building. There probably is a structural weakness in the building at this level which caused the damage. The upper portion of this frontage is but slightly injured. On the south front, the granite window heads of the first story on the east side are badly spalled. The annex at this side of the building is uninjured. The terra cotta above the

FAIRMONT HOTEL. Powell, Sacramento, Mason and California Streets. The façades, consisting of gray granite for the first story, and cream-colored terra cotta above, are but slightly damaged. The terra cotta around some of the window openings is spalled, and at the third-story level of the east side considerable damage has been wrought by the earthquake. The interior of this building is in bad condition on account of the buckling of between 30 and 40 columns, causing the floors to have a wavy effect and buckling and distorting the partitions in the upper stories. The buckling of the columns was caused by insufficient fire protection, many of them being simply within blind spaces enclosed by expanded metal lath and plaster partitions, and without independent protection. The metal lath and plaster ceilings fell in many places, on account of a weak wire clip which was used to support them. Notwithstanding the warped and distorted condition of the steel work, not a single span of the expanded metal concrete floors dropped out. Repairs to the exterior will be comparatively small, but almost the entire interior will require reconstruction.

FAIRMONT HOTEL. First Story. From the ball room, looking through the doorway into the corridor. Showing a buckled column that was simply enclosed in a large blind space between partitions. The latter were nowhere less than 18″ away from the column. The settling of the column deflected and buckled the partitions as shown.

FAIRMONT HOTEL. Third Story. Showing a badly buckled column, which was simply enclosed between metal lath and plaster partitions without independent protection. The partition leaning against the lower half of the column originally stood along the line where the plastered cove is ruptured at the ceiling.

FAIRMONT HOTEL. Third Story. Showing the failure of the flat expanded metal lath and plaster ceiling, due to the use of wire clips for supports from the beams. The section of the wire clip is so small that it is quickly heated and weakened so as to permit the ceiling to fall away. Note the column in the rear, which was protected by simply building a pilaster around it, projecting from the partition on one side and without light steel furring or other methods of anchoring the protection to it.

FAIRMONT HOTEL. Fifth Story. Showing a badly buckled, latticed channel column. The protection consisted of 4″ solid expanded metal lath and plaster partitions built around it. Note also the buckled piping which was enclosed in the same space with the column.

FAIRMONT HOTEL. Fifth Story looking down the corridor. This view is typical of the upper stories, and shows the distorted condition of the partitions and the warped surfaces of the floors, caused by the buckled columns in the lower stories. The man in the rear is standing in a depression, or low point, on the floor. The undulations of the floors can perhaps be best understood by following the intersection of the ceiling and partition at the right hand upper corner of the corridor. Only concrete floors and metal lath and plaster partitions would remain in position under such conditions.

FAIRMONT HOTEL. Sixth Story. Showing a badly buckled column protected by partitions built around it. The protection should have been independent of the partitions and should have been anchored to the column by suitable light steel furring at 12 to 16″ centres.

FAIRMONT HOTEL. Sixth Story. Showing a badly deflected and buckled column that was originally enclosed within expanded metal lath and plaster partitions, together with various pipes, etc. The bulging and distortion of the pipes no doubt contributed to the damage. At the ceiling level, the roof beams are still clinging to the column, although some of the rivets no doubt have been sheared. This distortion of the steel did not cause the concrete roof slab to fall out.

first story is in good condition, being but slightly spalled by the heat.

The levels on the water table indicate that the foundations remain in good condition, the southwest corner being about 3/8" lower than the other three corners. Observations on the walls indicate that they are practically plumb, the greatest variation being at the northeast corner, which leans to the east about 3/8".

This building was in the course of construction, and was almost ready for occupancy. The combustible contents of the building were limited almost exclusively to the wood finish. Although the exterior of the building has been but little damaged by the fire, the interior has been seriously damaged structurally by the failure of numerous columns. Some of the large rooms used as dining-rooms, ball-rooms, etc., of the first story escaped with very little fire, but considerable damage was done to the elaborate ornamental work and decorations by the smoke and the earthquake. The upper portion of the building was generally fire swept, and wherever fire attained any degree of intensity in the neighborhood of the columns, more or less damage invariably resulted. This was caused by the fact that the column protection was not anchored to the columns, the latter frequently being surrounded by partitions in a blind space of considerable size, which was utilized for piping, ducts, etc. When a column failed the partitions buckled or bulged out of line, disrupting the protection of adjacent columns, which were immediately exposed to the direct action of the flames. There are throughout this building probably 30 or 40 cases of the buckling of columns, giving the floors a wavy effect in the upper stories, and bulging and distorting the partitions.

The ceiling construction is also of an inferior character, on account of employing a wire supporting clip which soon became weak from the heat and allowed the lath and plaster ceiling to fall away.

Notwithstanding the warped condition of the steel-work, there are no failures of the concrete floor arches, which appear to be generally in good condition. Had there been a fire of greater length and intensity, a great many of the beams and girders would have been permanently deflected on account of the failure of the ceilings.

Between the wall furring and the exterior walls, there were frequently blind spaces extending through several stories. Flames entered these blind spaces in a few instances and set fire to sections of the building that otherwise would never have burned. The elevator fronts and stairways are but slightly damaged.

Comments:

By far the greatest damage to this building was caused by the inferior expanded metal lath and plaster column protection, permitting a large number of columns to buckle and settle. The columns that failed were almost invariably simply enclosed in a blind space between partitions, clearly demonstrating that it is exceedingly bad practice to depend upon partitions of this character for column protection. The blind spaces between the wall furring and the exterior walls extending through the various floor levels are also bad practice. The fire-proofing of the floors should in all cases extend against the outer walls and close all vertical spaces.

The damage to the exterior can be readily repaired. The restoration of the buckled columns will be a difficult and expensive operation and may involve the reconstruction of a large portion of the concrete floors. Many of the latter will require removal in order to obtain access to the connections, etc.

This building is another illustration of great damage caused by insufficient column protection. Had a few thousand dollars been spent in providing suitable column protection, a hundred thousand dollars in repairs would probably have been saved.

City Hall.

McAllister, Larkin and Leavenworth Streets and City Hall Avenue.

A. Laver, Architect. City and County of San Francisco, Owner.

Details of Construction:

The City Hall is a monumental building covering a large triangular block. It was three stories in height, with one main tower and three secondary towers. The walls are massive and are bearing walls. The floors are supported by steel girders and beams. The partitions are generally 21" or 17" walls, which also support the floors. The façades consist of highly ornamented brick walls with a gray cementine finish resembling

CITY HALL. McAllister, Larkin and Leavenworth Streets. This imposing structure covered a large triangular block, and was built by the city at an expense of $7,000,000.00. Practically all the damage was wrought by the earthquake, and was due to poor workmanship and an inferior grade of lime mortar. Fire subsequently destroyed all that was combustible in the *débris*. The steel work is badly deflected and distorted owing to improper protection. The fire-proof floors were of stone concrete of poor quality on corrugated iron centres. Many of the floor arches have failed. The building is wrecked and will be a total loss. The Hall of Records, an annex to this building, the dome of which shows behind a secondary tower on the right-hand side, was but little damaged by the earthquake. The interior, however, was completely fire swept, leaving nothing but the shell remaining.

CITY HALL. McAllister, Larkin and Leavenworth Streets. Showing the southwest corner. A large entablature supported by two columns is isolated from the rest of the building and remains standing. The entire upper portion of the heavy brick walls of this part of the building was overthrown, sections weighing as much as several tons remaining intact on the ground below. A mass of tangled steel framing which originally supported the roof is at the left-hand side. Practically all the mason work of the walls of the tower was shaken out.

limestone. The base is of granite to the water table. The ornamental cornice is of metal.

The fire-proof floors are of brick concrete in the form of segmental arches resting on corrugated iron centring. In the large rooms, the steel beams supporting the floors are 24″ deep and spaced 7 ft. apart. The thickness of the concrete is generally 6″, the top surface being parallel with the soffit of the arch, and leaving about 12″ of the upper part of the web and the upper flange of the 24″ beams exposed. 4″ x 6″ wood stringers were laid parallel with and on top of the floor beams, and 4″ x 4″ wood sleepers were laid over the stringers at 2 ft. centres, the finished wood flooring being laid over the sleepers.

The ceilings throughout, except in the basement, consisted of about No. 27 sheet iron supported at the under side of the beams by 1″ x ⅛″ angles at 2 ft. centres, the latter being attached to the beams by special clips. This sheet iron was formed or crimped so that slots about ½″ wide and of dovetail section faced the under side and afforded a key for the plaster. In the basement ceiling the soffits of the beams were left exposed.

The roof was supported on light steel framing, the spaces between supports being spanned by concrete slabs 2″ in thickness resting on flat corrugated iron. A fill of good quality was laid over this to grade the roof and level off the surface to the top of the steel members. The halls and public spaces were finished with glazed tiles.

The Hall of Records is located within about 100 ft. of the City Hall and connected with it by a covered walk. This annex is a circular building with a large ornamental dome. Several galleries, with floors about 20 ft. wide, were built around the outer wall of the building. This floor space was divided by wood stud and wood lath partitions into small alcoves or rooms. Access to the different galleries or floors was secured by two winding stairways, the space in the centre remaining open and forming a large rotunda under the dome.

Effects of the Fire and the Earthquake:

Almost the entire damage to the City Hall was caused by the earthquake. The greatest injury to the walls occurred on the west side of the City Hall Avenue front and the south side of the Larkin Street front. The entire upper portion of the outside walls was overthrown, causing the roof to collapse and wreck the southwest wing of the building. A large portion of the third story walls and parapets was overthrown in the other portions of the building also, distorting and wrecking sections of the roof, the *débris* of which broke down large sections of the flooring underneath. The *débris* of these heavy walls is lying on the ground around the structure, some of it consisting of large sections of the wall weighing as much as several tons.

The large ornamental columns of the exterior consisted of cast-iron pipes of ½″ metal filled with a poor quality of brick concrete. Many of these columns fell and broke in small sections. A chimney on the west side fell inward and destroyed several sections of flooring in its path to the cellar.

An examination of the mortar used in the brick-work of this building discloses the fact that it was lime mortar of ordinary quality.

The floor beams throughout are badly deflected by the heat. This was caused by the large amount of wood-work in the floor finish, and the fact that there was no filling between the concrete arch and the wood flooring to protect the upper portion of the floor beams. The average deflection of the steel beams, in the large rooms where the spans are approximately 40 ft., is from 10″ to 15″. There are numerous failures of the floor arches where there was no apparent load supported by them. The sheet-iron centres when heated afforded no support, and the concrete arches being of poor quality, when the beams deflected, dropped out. Wherever any *débris* fell on these arches from above, failures almost invariably resulted.

The sheet metal and plastered ceilings dropped away quite generally from the supports and fell to the floors below. All the ornamental work is badly damaged and much of it is down. Very little plaster adheres to the brick dividing walls in the interior. The glazed tile floor finish of the corridors is warped and cracked, and all the glazed tiles are loose, but most of them are whole. The cast-iron and marble tread stairways throughout the building are little damaged where they have not been wrecked by falling *débris*.

The Hall of Records annex was only slightly damaged by the earthquake. A small section of the outside wall at the third story level on the west side was shaken out, and a few small

cracks appear in different places in the outside walls. The interior of the building, however, was fire swept, and nothing remains on the main floor or the gallery floors but plaster and ashes, the wood stud and wood lath partitions having completely disappeared.

Comments:

This building, erected by the City and County of San Francisco at a cost of $7,000,000 by day's labor, is a complete wreck. The walls are in ruins. What is left of the metal frame can only be disposed of as scrap. The only portions of the building that remain in fair condition are those sections of the stairways which have not been damaged by falling *débris*. The foundations can probably be utilized for a new building.

The damage to the Hall of Records can be repaired and the building restored.

Union Ferry Building.

Foot of Market Street.

A. Page Brown, Architect. State of California, Owner.

Howard Holmes, Supervising Engineer.

Details of Construction:

This building is a large three-story structure, approximately 100′ x 600′, with a ten-story tower. It is used, as the name implies, as a depot for all the ferries. The Market Street façade consists of Colusa sand-stone, the cornice being of the same material. The floors are supported by cast-iron columns and steel girders and beams, the tower having a steel skeleton frame. The walls are self-supporting. All the walls and columns rest on pile foundations. The first floor is supported by groined concrete arches springing from concrete piers founded on cluster piles.

The concrete floors above the ground level are of the expanded metal, flat arch type, consisting of a flat slab of concrete with 3″ diamond mesh expanded metal imbedded near the under surface. The spans will average about 7′ 6″ between beams. The floor finish at the ground level is of cement, and in the second story corridors it is of terrazzo and mosaic. In the other parts of the building there are wood floors with sleepers and sleeper fill.

There was no fire in this building. All the damage was wrought by the earthquake.

Effects of the Earthquake:

Small areas on the east and west sides of the tower under the clock were shaken out. The middle section at the top of the south wall, about 8′ x 40′ in area, fell out, breaking down the shed below it. The large steel flagpole on top of the tower was permanently bent. The driveway openings in the north and south wings have the side piers badly cracked. The piers of the arches south of the central section and south of the southern driveway are spalled. The tower walls are damaged so that five stories will probably have to be taken down and rebuilt.

The street surface at the N. W. corner settled 2′, cracking the asphalt pavement and carrying down a large section of the sidewalk. The interior plastering and other finish is slightly damaged.

Comments:

The Ferry Building is located on filled-in ground and on the water front. Careful observations since the earthquake have shown that its effects were much more violent and disastrous on filled-in ground than on original soil. The wonderful manner in which the Ferry Building withstood the effects of the earthquake must be ascribed to the stability and excellence of its pile foundations.

Very little structural damage was sustained by this building, and its complete restoration will be readily accomplished.

Globe Mills.

Chestnut and Sansome Streets.

W. E. Keller, Architect. Globe Grain and Milling Co., Owner.

Details of Construction:

The main Mill Building is four stories in height. The walls are of concrete to the ground floor level and of common brick above. All the walls are bearing walls. The metal frame consists of cast-iron columns and steel girders and beams.

The fire-proof floors are of stone concrete flat slabs reinforced with ¼″ rods, spaced 12″ apart. The soffits of the beams and girders are unprotected. The cast-iron columns are also unprotected. The floors are finished in cement.

The roof consists of steel framing covered with corrugated iron and supported by large trusses.

Connected with the main building was a large two-story warehouse on the east side. The walls of the warehouse are of concrete to the second floor level and of brick above. The roof was supported on trusses, and was similar to that of the main building. The span of the trusses was about 60 ft.

The floors were finished in cement, the lower floor resting directly on the ground. The second floor was of the expanded metal, flat slab type, of stone concrete, the spans being about 5 ft. The columns were unprotected and the soffits of the girders and beams were also left exposed.

Effects of the Fire and the Earthquake:

The walls of the main Mill Building are but little damaged, a few cracks having been developed by the expansion of the unprotected steel-work. The mortar used was probably gauged with Portland cement, as it was of better quality than the average mortar used in much of the brick-work that failed elsewhere.

In the east side of the building, where large bins and machinery are located, the floors at the different levels are omitted in numerous places, the bins extending through several stories. In this room, nine columns buckled and were being replaced at the time the building was inspected. A number of floor arches had been removed in order to get access to the connections in making the repairs. The roof trusses on the south side of this section of the building are badly distorted by the heat, and three columns have been deflected.

The warehouse was completely filled with grain on the ground floor and flour on the second floor. This produced a fire of long duration and considerable intensity. The roof trusses over the second floor were soon heated and failed, pulling in the brick walls and causing the wreck of the entire building.

Comments:

The good condition of the walls of the main Mill Building is probably due to the superior mortar used and the fact that the entire building is founded upon solid rock.

Had the columns in this building been protected, it would have probably resisted the fire successfully and sustained no structural damage.

The total wreck of the warehouse, where the large roof trusses and other structural steel members were unprotected and where large quantities of grain and flour were stored, could have been anticipated. In a building of this character, the most efficient protection that it is possible to provide is necessary in order to avoid destruction in case of a fire. The window and door openings of such warehouses should be specially safeguarded against fire.

Tivoli Opera House.

S. W. Cor. Mason and Eddy Streets.

Shea & Shea, Architects. Mrs. Ernestine Kreling, Owner.

Details of Construction:

The Tivoli Theatre is three stories in height at the front or main entrance. All the exterior walls are of brick, the front having a highly ornamental treatment with a cementine finish. The cornice is of galvanized iron. The entrance lobby and lounging rooms above are of fire-proof construction. The auditorium, balcony, gallery, stage and dressing rooms were of wood construction, supported by steel columns and framing. The roof was also of wood construction, covered with tin and supported by large steel trusses.

The fire-proof floors in the front portion of the building are of the flat slab type, of cinder concrete, the spans between the beams being 5 to 7 ft. The partitions in this part of the building were of the double, hollow, expanded metal lath and plaster type. The columns throughout were protected by expanded metal lath and three coats of plaster. An expanded metal lath and plaster ceiling was erected under the various floors and roof throughout.

Effects of the Fire and the Earthquake:

The auditorium portion of the building is completely wrecked, the steel-work being twisted and warped into all manner of grotesque shapes and is strewn in a tangled mass all over the in-

TIVOLI OPERA HOUSE. Showing the ruins of the auditorium and stage portions, which were of non-fire-proof construction. The floors and finish were of wood, the floor loads being carried on steel framing and bearing walls. In these ruins were evidences of the hottest fire noted in the burned district. Expanded metal lath was incinerated. Latticed angle column sections and light trusses were blistered and burned so that they parted, $\frac{1}{4}''$ metal being reduced at the fractures to the thickness of ordinary pasteboard. The three-story entrance portion of the building is of fire-proof construction and remains standing.

terior at the ground level. Two of the rear walls are overthrown, and large portions at the top of the remaining walls have also fallen down. The front portion of the building, which was of fire-proof construction, remains standing, everything combustible within it having been consumed. The fire-proof floors are uninjured, except small portions adjoining the wrecked section, which were damaged by falling *débris*.

Comments:

The large amount of wood-work used in the construction of the non-fire-proof portion of this building, and the manner of construction, furnished favorable conditions for an extremely hot fire.

Large quantities of the light iron castings of the seats were fused. Light latticed channel columns were blistered and scaled in numerous places, so that little of the original section remains. In one case the column section was completely severed, the edges of the burned sections being no thicker than ordinary pasteboard. These phenomena would indicate temperatures of 2200 to 2500 degrees Fahr., which is as intense a heat as was observed anywhere in the burned district. One of the curious phenomena observed was a large quantity of wire glass, which had evidently been used in the skylight over the stage. This was fused and fell over the twisted and distorted steel-work in very interesting and weird shapes, some of it hanging in shreds and swaying in the wind, resembling the gray moss on the live oaks in the South.

Linda Vista Apartment House.

S. E. Cor. Turk and Jones Streets.

M. J. Lyon, Architect. Isaac Liebes, Owner.

This was a steel skeleton frame building with curtain walls and was used as an apartment house. It was approximately 25 x 70 ft. in plan.

The fire-proof floors were of the Roebling System B, or flat slab type, the spans between the beams being from 7 ft. to 12 ft. The columns were protected by light steel furring and wire lath covered with three coats of plaster. Flat Roebling wire lath and plaster ceilings were erected underneath all the floors except in the basement, where the beams and girders were protected with crimped wire lath and cement plaster. The finish of the floors was of wood on wood sleepers and sleeper fill.

This building passed through the earthquake without any injury whatever, but when the fire approached the section in which it was located it was dynamited by the authorities and overthrown. All that was combustible in the *débris* was subsequently consumed by the fire.

A careful examination of the piers in the basement shows that all of these have been bulged outward from the centre of the building, indicating that the heavy charge of dynamite was probably discharged near the centre of the building in the basement.

Sub-Stations, San Francisco Gas and Electric Company.

San Francisco Gas and Electric Co., Architect and Owner.

EIGHTH STREET SUB-STATION.

East Side of Eighth Street, near Mission Street.

Details of Construction:

This is an old style, three-story building, about 25 ft. x 70 ft. in plan. The walls are of brick and are bearing walls. The second floor is supported by cast-iron columns and steel framing. The third floor and roof are of wood construction.

The concrete floor at the ground level rests directly on the ground except the part over the tunnel for cables, which is of the flat slab type of stone concrete. The floor arches of the second floor are also of stone concrete, but segmental in form. The floor finish of the first and second floors is of cement. The cast-iron columns and the soffits of the beams and girders are unprotected.

Effects of the Fire and the Earthquake:

There are earthquake cracks in all the walls. The third floor and roof burned off, causing the upper portion of the walls all around the building to fall away. The round cast-iron columns in the first story are badly deflected, but still support the floor above. The cement floors are in good condition, and the cement finish is but slightly damaged.

LINDA VISTA APARTMENT HOUSE. Southeast Corner Turk and Jones Streets. Showing the total destruction of a nine-story, steel skeleton, fireproof building by dynamite. This building withstood the earthquake without damage, and was dynamited by the authorities when the fire threatened this section of the city. The Roebling cinder concrete floors were of the flat slab type, and the partitions were of Roebling wire lath and plaster, finishing 2″ in thickness. The fire subsequently consumed all that was combustible in the *débris*.

MISSION STREET SUB-STATION.

Mission Street, near Third Street.

This is a three-story brick building, almost a duplicate in size and style of the Eighth Street Sub-Station, the details of construction being identically the same as that building.

The wood roof of this building was consumed, and portions of the third-story wall are down. The concrete arches of the first and second floors remain in first-class condition. The brick walls are in good condition, there being only a few slight earthquake cracks visible.

HYDE STREET SUB-STATION.

Hyde Street, between McAllister Street and Golden Gate Avenue.

Details of Construction:

This is a two-story building, about 25 ft. x 60 ft. in plan. The front consists of cast-iron ornamental columns and glass for the first story and pressed red brick for the second story. The sides and rear walls are of common brick and are bearing walls. There are window openings only in the front and rear walls. The first floor is of concrete and rests directly on the ground, except a small portion over the cable tunnel. The second floor is supported by steel beams and girders and cast-iron columns.

The fire-proof floors over the cable tunnel and at the second floor level are of the expanded metal, flat slab type of cinder concrete about 4″ in thickness. The soffits of the beams and girders are protected by expanded metal lath and plaster. The cast-iron columns were left exposed.

Effects of the Fire and the Earthquake:

The front is but slightly damaged. The wood roof has disappeared. There is apparently very little earthquake damage to the walls. The exposed cast-iron columns have been badly deflected by the heat. The concrete floor arches are in good condition. In a few spots the expanded metal is exposed on the under side of the concrete.

Comments:

The three sub-stations above described are of similar construction. All of these buildings would have developed excellent fire resistance had the roofs and upper floors been of fire-proof construction, with the openings protected by fire-proof barriers. The structural steel and cast-iron columns should also have been protected.

Claus Spreckels or Call Building.

S. W. Cor. Third and Market Streets.

Reid Bros., Architects. Claus Spreckels, Owner.

Details of Construction:

The Spreckels or Call Building is the tallest, most conspicuous and most celebrated building in San Francisco. It is an office building nineteen stories high, and is the publication office of the San Francisco *Call*. It was erected in 1897.

The façades consist of gray granite to the water table and Colusa sand-stone above. The cornice is also of sand-stone. The dome is ornamented with terra cotta and is roofed with copper.

The metal frame is of the steel skeleton type, resting on grillage foundations, the walls being curtain walls. The foundations are very elaborate, projecting considerably outside of the building line and resting upon compact sand.

The fire-proof floors in the lower stories are of the flat slab type, of cinder concrete, 17″ in thickness, without any reinforcing metal. The under surface of this slab is 2″ below the soffits of the beams, which are protected by filling the slot under the beam with plaster flush with the concrete. Above the seventh floor the arches are segmental in form, 7″ thick at the crown, without metal reinforcement, and with flat wire and plaster ceilings underneath.

The hall partitions are of hollow tile blocks 6″ in thickness. The other partitions, the wall furring and the column covering are of 3″ hollow tile blocks. The floor finish is of wood laid over wood sleepers and sleeper fill. The halls are finished in mosaic.

Effects of the Fire and the Earthquake:

The entire Third Street front of the building is badly damaged by the fire, the window openings of the first story being spalled the most. The south front (which consists of brick for

EIGHTH STREET SUB-STATION of the San Francisco Gas and Electric Co. First Story. Showing the condition of the unprotected cast-iron columns, switch boards, machinery, etc. The segmental stone concrete arches of the second floor remain in good condition. This view is typical of two other similar buildings owned by the same company in other parts of the city.

four stories, where it adjoined another building, with sandstone above) is also badly spalled around the window openings, but it is not as much injured as the Third Street side. The Market Street front is in good condition, a few of the window openings only being slightly spalled, those on the west side having suffered the most. The west front of the building is considerably more damaged than the Market Street side. The window openings are spalled and the veneering of the surface is cracked and spalled in spots. There were no earthquake cracks observed in any of the walls.

The levels on the water table show that the foundations remain perfectly level. The greatest variation of the walls from the plumb is at the northeast corner, where the Market Street front leans to the south about 1″.

The steel skeleton frame and the concrete floors throughout are uninjured. The hollow tile partitions failed quite generally, and about 40 per cent. of the blocks have fallen down. The wall furring and the column covering is considerably damaged and has partially failed in many places. The column protection, however, fulfilled its object sufficiently to prevent any column failures.

It was noted that the hollow tile partitions and column covering in the stories below the seventh floor, where they were built between rigid surfaces top and bottom, were in much worse condition than in the upper stories, where they were built to the under side of the wire lath and plaster ceilings. Most of the partitions which remained standing in the lower stories were badly cracked and damaged, some of the injury probably being caused by the earthquake.

The wire lath and plaster ceilings in the upper stories are generally in good condition, most of the plaster still adhering to them. The suspended ceilings in the corridor around the elevator shaft, on account of improper fastenings and their being built into hollow tile partitions, failed in nearly every story. Some of the ornamental furring and wire lathing in the club room of the San Francisco Club on the seventeenth story failed also on account of insufficient supports.

In the sixteenth story café and in the billiard-room, the ornamental furring and lathing remains in good condition. In the nineteenth story considerable steel-work is exposed. This part of the building evidently was never entirely finished. There was, however, little of a combustible nature to burn in this story, and consequently there is no apparent damage.

The cast-iron and marble tread stairway in the lower portion of the building was completely wrecked by falling partition blocks and other *débris*. The elevator fronts throughout are distorted and bulged, and the framing in the shaft is deflected and out of line. The mechanical plant in the basement is only slightly damaged.

Comments:

Ever since this building was erected, it was predicted that in the case of an earthquake it would certainly be wrecked or overthrown. The magnificent showing which it made is a great triumph for engineering skill, and should inspire confidence in this type of building. The slight variation of the walls from the plumb is no more now than it was before the earthquake. At any rate, observations do not indicate that there has been any permanent displacement of the foundations or the walls.

This is one of the few buildings in which provision was made for the vertical pipes, which are carried through separate ducts and not along the columns inside of the column protection.

The repairs to this building will be quite extensive on account of the damage to the exterior, especially the Third Street and south fronts, which will probably require complete renewal. The Market Street front can probably be repaired. In the interior, the repairs will be limited almost exclusively to the restoration of the stairways, partitions, elevator fronts and finish.

Bell Theatre.

South Side of Market Street, between Seventh and Eighth Streets.

Reid Bros., Architects. Charles N. Felton, Owner.

Details of Construction:

This building has a three-story front on Market Street. The façades consist of cream terra cotta pressed brick, with terra cotta ornaments. The rest of the walls are of common brick.

This building was in the course of construction and had not been occupied at the time of the fire. The metal frame is of steel, the walls being self-supporting. The fire-proof floors

CLAUS SPRECKELS (OR CALL) BUILDING. S. W. Cor. Third & Market Sts. The façades are of Colusa sandstone. The entire Third St. front is badly scaled and spalled by the fire. The south front is also similarly damaged, but in a lesser degree. The Market St. front is in good condition, only a few window openings being damaged. The west front, while considerably more damaged than the Market St. side, can be repaired. The foundations remain level, and the walls plumb. The steel skeleton frame is uninjured. The concrete floors throughout are in first-class condition. The hollow tile partitions, column covering and wall furring have been greatly damaged and are in bad condition. This is the tallest and most celebrated building in San Francisco, and is structurally uninjured.

CLAUS SPRECKELS BUILDING. First Story. Showing the damage to the hollow tile wall furring, column covering, hollow wire lath partitions and wire lath ceiling. Note the hollow tile *débris* on the stairway at the left. The stairways in this building were totally wrecked by hollow tile and other *débris*. The concrete floors are in first class condition throughout.

are of the expanded metal, flat slab type, of cinder concrete. A ceiling of expanded metal lath and plaster is erected under the gallery, balcony and roof.

Effects of the Fire and the Earthquake:

The Market Street front has sustained very little damage. The parapet balustrade on the east side was shaken out. The east and west brick walls have a few small earthquake cracks. A section about 5 ft. x 30 ft. near the centre, on the top of the west wall, was shaken down. The south wall is cracked loose from the west wall at the southwest corner, from the top to the bottom, and is separated from it at the top by about 8″. It also has a horizontal crack about 8 ft. from the top to the centre of the building. The metal frame and the concrete floors are uninjured.

Comments:

There was very little fire in this building, and the interior is in good condition. Much of the wood finish remains, but considerable damage has been caused by smoke and by earthquake cracks to the plaster-work.

The repairs to the interior will be comparatively light. Sections of the walls will require reconstruction, but the complete restoration of the building should be speedily and easily accomplished.

Jackson Brewery.

N. E. Cor. Eleventh and Folsom Streets.

Details of Construction:

This building was in the course of construction. The outside walls of common brick had been carried up to the second and third story levels. The walls were bearing walls. The floor loads were supported by cast-iron columns and steel framing.

The fire-proof floors consisted of segmental stone concrete arches without reinforcement in the east extension, and flat slab type concrete arches, reinforced by 1½″ x 2½″ rectangular mesh fencing of No. 16 wire in the main building.

Effects of the Fire and the Earthquake:

Practically all the damage to this building was wrought by the earthquake. A large portion of the walls that had been finished was shaken down. The support of the beams being thus removed, the steel work failed, and many of the concrete arches dropped out.

A peculiar result produced by the earthquake was observed in the central portion of the building at the third floor level, where five beams remain in position with planking over them, supporting a load of several tons of brick-work that fell on them. These beams have no support whatever except the angle connections to the girder at one end, and do not appear to have deflected materially.

Comments:

This building is completely wrecked. The portions that remain standing will require reconstruction. There was no fire damage, except that scaffolding and temporary work has been consumed.

The weakness of the brick walls and the damage to them was caused by the inferior lime mortar.

Whittell Building.

North Side of Geary Street, between Stockton Street and Grant Avenue.

Shea & Shea, Architects. Geo. Whittell, Sr., Owner.

This is a sixteen-story building in the course of construction. It is remarkable, for the reason that the entire steel skeleton frame has been erected complete without any walls or fire-proof floors.

The levels on the water table indicate that the foundations have not been displaced and remain practically level. Observations on the columns do not indicate that they are out of plumb.

There was no combustible material to cause any structural damage to this building, except some scaffolding lumber that was piled on the tier at the ground level. The burning of this caused the deflection and warping of some of the beams, which is the only damage that was observed.

This building is particularly interesting to the structural engineer. The steel skeleton frame, without any masonry or floors, had sufficient strength and rigidity to resist the sudden and racking motions of the earthquake.

JACKSON BREWERY. Northwest Corner of Eleventh and Folsom Streets. This building was in the course of construction and was totally wrecked by the earthquake. Lime mortar of poor quality was used. All the walls were bearing walls and were not tied together. Fire did not enter the corner of the building shown in the foreground, but consumed everything combustible in the rear. Note the five beams at the third story level projecting toward the rear which carry a load of brickwork on planking, with no other support than the angle connections to the girder at one end.

Butler Building.

S. W. Cor. Stockton and Geary Streets.

Reid Bros., Architects. Mrs. Emma Butler, Owner.

This is a large fire-proof building that was in the course of construction at the time of the fire, the steel skeleton frame having been carried to approximately the sixth floor level, and the walls to the third floor level. No fire-proof floors had been installed before the fire.

There was little of a combustibe character about this building at the time of the fire, and very little damage was sustained by it. Some lumber for scaffolding, etc., stored on the lower floors, caused sufficient heat to warp a few of the floor beams. A few rivets in the steel-work were also sheared by the earthquake.

Stock House, Albany Brewery.

East Side of Eighth Street, between Harrison and Bryant Streets.

The Albany Brewery consisted of a group of buildings, all but the Stock House being of ordinary construction, with walls of brick and the floors and posts of wood.

In the southwest corner of the Stock House were several sections of stone concrete floors between steel beams, and supported by steel girders and cast-iron columns. The concrete floors were reinforced by No. 18, 2″ hexagonal mesh netting in some cases, and by double No. 14, twisted wire strands in other cases. The top surface of the floors was finished with cement.

The entire group of buildings was consumed, including the wood portion of the Stock House. The southwest corner, containing the fire-proof floors of short spans, remains in good condition, but some of the concrete floors of longer spans failed on account of the light reinforcing metal and the fact that it was not carefully imbedded in the concrete.

Stock House, Wreden Brewery.

Cor. Lombard and Taylor Streets.

Martens & Coffee, Architects. Claus Wreden Brewing Co., Owners.

This is a three-story structure. In the north end the floors are of fire-proof construction, and are of the Roebling system B, or flat slab type, of cinder concrete, the spans between the beams being about 6 ft. In the south end of the building the floors are of wood. The roof over the entire building was of wood. The walls are of brick and are bearing walls. The floor loads are supported by cast-iron columns and steel girders and beams.

The wood roof and the floors in the south end of the building were consumed by the fire. The fire-proof floors in the north end of the building remain in good condition, supporting the loads that were originally placed on them, consisting of large casks. The upper fire-proof floor also carries a considerable quantity of *débris*, which fell on it when the roof was consumed.

The exterior walls appear to be in good condition and show no signs of earthquake cracks, the walls having been well tied together with steel rods.

California Wine Association Building.

Townsend Street, between Second and Third Streets.

Details of Construction:

A two-story section of a brick building remains standing amidst the ruins of other buildings at this location. The walls are bearing walls. The floor loads are supported by cast-iron columns and steel girders. The floor slab is of stone concrete, 4″ thick, and is supported by reinforced concrete beams at 5 ft. centres, extending from girder to girder. The columns and girders are spaced 17 ft. 6 in. apart. The doors in the lower story are metal covered, and the windows are glazed with wire glass. This building is also known as the Casa Calwa Warehouse.

Effects of the Fire and the Earthquake:

The damage by fire was small. A section of the brick wall on the east side, near the front of the building, was overthrown by the earthquake, allowing one of the steel girders supporting the reinforced concrete flooring to drop to the first floor. The reinforced concrete floors supported on the other sides remained in position, but are deflected about 5″. The reinforced concrete beams were disrupted and damaged adjacent to the girder.

CLAUS SPRECKELS RESIDENCE. Southwest Corner Clay Street and Van Ness Avenue. The façades of brown stone are badly spalled around the window openings. The earthquake damage to the walls is slight. This was the only fire-proof residence in the burned district.

Claus Spreckels Residence.

S. W. Cor. Clay Street and Van Ness Avenue.

Reid Bros., Architects. Claus Spreckels, Owner.

Details of Construction:

This is a four-story building with a mansard roof. The façades are of brown stone. The fire-proof floors are of hollow tile, flat arches, supported by steel framing. The walls are bearing walls.

Effects of the Fire and the Earthquake:

Although located on the west side of Van Ness Avenue, flames entered this building and destroyed everything combustible within it. Nearly all the plaster has fallen away from the ceilings and walls. The steel frame is apparently little damaged. The brown stone is badly spalled around the window openings. The earthquake damage to the walls is slight, if any.

The soffits of some of the hollow tile blocks have fallen away, exposing the cellular spaces. The hollow tile partitions are badly damaged and down in some places.

Comments:

The advantage of fire-proof construction for residences is apparent by comparing the illustration on page 239 with that on page 22.

GENERAL COMMENTS AND CONCLUSIONS.

IN the location of future town sites, and in the construction of buildings and public works in California and other regions subject to earthquakes, the geological formation should be carefully studied. Locations in proximity to fault lines should be avoided.

Location of Important Structures.

When the locations are controlled by physical or special conditions, as in the cases of reservoirs, water mains, railway bridges, etc., and the erection of such improvements near fault lines is unavoidable, the very best talent and experience should be enlisted to prepare suitable and efficacious designs.

The fault line of the recent earthquake passes along the west side of the San Francisco peninsula, which renders the location of the city most unfavorable. Special attention and care should therefore be given to the planning and construction of future buildings, in order to avoid a repetition of the recent damage and destruction.

The underlying material of the city of San Francisco consists generally of a compact sand and, in a few locations, rock. Both of these materials are excellent for founding purposes and well adapted to support heavy structures. The foundations of nearly all the high buildings rested on sand. In all cases where the foundations were well designed, they were seldom displaced or damaged. Where the soil was soft or had been artificially filled in, piles were resorted to with success. Wherever the foundations were displaced, they were either poorly designed or were not of sufficient depth to reach stable material.

Sub-soil of the San Francisco Peninsula.

The very extensive damage caused by the earthquake to mason work is, without doubt, due to the poor quality of lime mortar that was generally used in this work. The most accessible supply of this material is shore or sea sand, which, in the neighborhood of San Francisco, contains a large percentage of loam. It is therefore poorly suited for mortar, and when used, produces a mortar of inferior quality. The workmanship was also far from the best in many cases. Bonding was not properly attended to and very frequently in the case of brickwork, the bricks were not suitably moistened before placing them in the work. All these details contributed to weakness in the construction and rendered the mason work erected under these conditions poorly adapted to withstand earthquake shocks.

Cause of the Extensive Earthquake Damage.

In all cases where a good quality of lime mortar or Portland cement was used, and where the workmanship was fairly good, much less damage was noted, and the results were always vastly superior to the average work. Had first-class mortar or cement been employed, combined with good workmanship, the injury to ordinary mason work would probably not have been more than 10 per cent. of the actual damage.

Walls tied together with rods or straps always showed better results than those without such ties. Interior cross or dividing walls served also to brace and stiffen the buildings and to distribute the stresses and strains induced by the surface movements. Buildings embracing these features, and without steel frames, while very few in number, were practically uninjured by the earthquake. The Palace Hotel is a good example of such construction.

In Class B buildings, which were permitted to heights of 100 feet, the walls were tied only by the anchors of the steel beams which they supported. The instability of these walls and their insufficient ties were causes of frequent failures in the earthquake and resulted in extensive damage to adjoining property.

A prevailing practice in San Francisco was to employ self-supporting walls in connection with the steel frames. These walls were simply built around the wall columns along the building lines. Such walls were frequently moved away from the steel frames, and in some cases were shaken down or remained in an unsafe condition. This is not good practice in locations subject to surface movements. Better results were always found when the walls were tied at frequent intervals to the columns and to the wall girders.

Curtain walls, supported by the steel frame, in all cases made the best showing and when laid in good cement mortar were never injured.

High Chimneys and Towers.

High towers and chimneys of mason work should be carefully avoided, unless held together by a steel skeleton frame. Such structures proved to be extremely dangerous and invariably failed at mid height, the upper half falling to the ground and crushing everything beneath it. High chimneys can be built with equally satisfactory results, of steel riveted at the joints and safely supported and braced by guy ropes or steel rods. Ornamental towers can similarly be executed in light steel framing and reinforced concrete.

Satisfactory Behavior of the Tall Buildings.

The successful manner in which the tall buildings withstood the effects of the earthquake was most gratifying to those who designed them. These buildings had never before been subjected to violent earthquake shocks, and many architects and engineers doubted their ability to withstand such surface movements without injury. Their very satisfactory behavior under the recent severe test furnishes also abundant and conclusive proof that the principles involved in their design are correct. In all cases when the structural details were designed in accordance with the best modern practice and executed with skill and workmanship of only fair quality, the buildings passed through the earth-

quake without structural injury. Even the tallest buildings, such as the Spreckels, Mutual Savings Bank, The Flood, The Merchants' Exchange, The Chronicle Annex, the Hotel St. Francis, and others, remain practically plumb. The small variations of an inch or less in a height of 100 feet that have been noted in the detailed descriptions of the buildings are inappreciable and unimportant. The high buildings of Chicago, for example, which have never been subjected to earthquake shocks, show, in many cases, greater variations from the plumb than were generally noted in San Francisco. It is probable, therefore, that the majority of the buildings that remain in good condition have not been in the least displaced by the earthquake.

In order to secure immunity from earthquake damage for the steel skeleton frame buildings, it is evidently essential that the entire design should be rational and well balanced, the parts being so related that the *ensemble* will act as a unit, and in case of surface disturbances, move with the surface *en masse*.

Injury to the Façades.

The exteriors of all the fire-proof buildings were more or less damaged by the fire. In some cases the damage was caused by flames from the interior, spalling surfaces around the window openings, and in other cases the whole surface of certain fronts have been scaled and spalled by exterior heat generated by the combustion of other buildings.

Materials Employed in the Façades.

The materials generally used for the façades of the San Francisco buildings were granite from the Raymond, California, quarries and a gray sand stone from Colusa County. In a few buildings brown stone was used. The ornamentation was frequently executed in architectural terra cotta. Of these materials, the terra cotta proved the most refractory. When properly designed and set in a first-class manner, the results are fairly satisfactory. In many cases, however, where the cores were large and the shells of the material less than 2″ in thickness, it spalled and cracked under moderate heat. Of the other materials named, granite proved to be the least refractory. It was frequently damaged by the heat caused by the burning of scaffolding that was placed in erecting it. At the United States Post-Office building much of the granite base and coping at the sidewalk level was spalled and injured by the burning of trunks and bundles of wearing apparel, deposited near it by refugees. The sand stone generally developed better fire resistance than the granite, but was also badly disfigured when subjected to moderate heat. Of all these materials, terra cotta alone, when designed with heavy shells and executed in a first-class manner, is capable of withstanding the normal conditions which exist in a conflagration. The window heads of the Young Building can be cited as an instance where terra cotta developed excellent fire resistance, and was properly anchored in position.

Various varieties of brick were also used in the façades. A silica brick, stamped with a diamond enclosing the letter S, proved very refractory and gave excellent results. The buff pressed terra cotta brick next to the silica brick developed the best fire resistance. The common red pressed brick was also used and gave good

SPALLED GRAY SANDSTONE. South side of Post Street, between Stockton Street and Grant Avenue. Showing a portion of the front of the Friedman Furniture Store.

SPALLED RED SANDSTONE. Northeast Corner Post and Stockton Streets. Showing a portion of the Pacific Union Club's new building.

RUINS OF A CLASS B BUILDING. East Side of Third Street south of Mission Street. Showing the typical condition of buildings with wood floors supported by unprotected steel framing and bearing walls. Also showing a badly spalled granite column base.

results. As in the Baltimore fire, and in every large conflagration, the common brick developed good fire resistance and was seldom damaged by the heat. When injured from this cause, it was in local spots where abnormally high temperatures were produced by special conditions.

Whenever brick was used for the façades, the bonding was seldom carefully done. Sometimes metal clips were depended upon solely for this purpose. In most cases every sixth to eighth course was bonded to the backing. There were numerous instances where the bond of the face brick was broken and they were precipitated to the ground. In future work this detail should be carefully attended to and at least every third or fourth course should be bonded to the backing.

There is, at the present time, a large demand for a new material which is adapted for exterior ornamentation and which is sufficiently refractory to resist damage when subjected to the heat and other conditions of extensive conflagrations.

Structural steel of standard and conservative design made a good record. When thoroughly braced, as in the case of the Spreckels Building, Mutual Savings Bank, Crocker Building and the St. Francis Hotel, there were no earthquake cracks in the exterior walls. Where bracing was not carefully provided, X cracks occurred in the middle height of the buildings, generally in the piers between window openings. It would therefore seem essential, in order to provide for the special conditions of earthquake tremors, that the middle section of all high structures should be specially strengthened by braces and ties. The usual practice of splicing columns and changing from larger to smaller sections at the same level, is undesirable and should be avoided in future buildings. Columns of open section are always preferable, on account of their adaption to decreasing loads without changing their outside dimensions and their greater strength at the splices. Riveted connections, under the same conditions, always developed greater strength and better results than when they were bolted.

Structural Steel.

In the case of distorted steel work, it was, in many cases, impossible to determine in what manner the connections had been wrenched out of position; that is, whether the angles or lugs failed or whether the rivets and bolts sheared; these details, in all cases, being covered up by building materials. In the case of extensive failures in the lower stories of some of the buildings, the *débris* surrounded and completely covered the points of failure. Much valuable information and data in connection with these failures will no doubt be ascertained later, after the obstructions and over-burdens have been removed.

Cast-iron columns were used in some of the fire-proof buildings and were generally employed in the Class B buildings. On account of less rigidity in the methods of framing in connection with cast-iron columns, they should not be used in high buildings in the future. Under abnormal strains, as, for example, when columns buckled so as to warp the framing, the lugs frequently snapped

Cast-iron Columns.

WAREHOUSE. Beale Street, between Howard and Folsom Streets, occupied by The Dunham, Harrigan and Hayden Company. Showing the effect of an intensely hot fire which destroyed cast iron columns. The metal where the columns have been severed is very little thicker than ordinary pasteboard.

and permitted the framing to fall away and wreck whole sections of certain buildings. For low buildings, in cases where the columns are to be left exposed, and other special conditions, cast-iron columns may sometimes be used to advantage. They are slightly less affected by heat than steel columns when unprotected.

The burning of the Class B and other large buildings with wood interiors, generally produced higher temperatures than the contents of the fire-proof buildings. There were numerous instances in the former buildings where cast-iron columns were literally burned in two and where light steel members were similarly severed.

Comparative Temperatures.

The burning of neighboring or adjoining buildings, contrary to popular belief, has very little or at least no appreciable effect on the temperatures within the fire-proof buildings. This can be understood more readily perhaps in consideration of the fact that a temperature of 1800° F. can be maintained for four hours on one side of a 12″ brick wall before the other side becomes sufficiently heated so that the hand cannot remain on it. The temperatures that test the different materials of construction and finish in the interiors of the fire-proof buildings are therefore those generated within the structures themselves, and the results are entirely independent of the existing conditions on the outside.

The intensity of the heat and the duration of the fire in the interior of the fire-proof buildings varied greatly, and depended upon the conditions of draught and the amount and character of the fuel or combustible contents. In office buildings and hotels, this fuel generally consisted of the wood finish, the furniture and the furnishings. These were generally ignited after the glazing of the windows had been destroyed and the frames and sash were burning. Consequently, draughts were induced which fanned the fire, producing high temperatures as long as the fuel lasted. Under normal conditions, the duration of the fire did not exceed 20 to 30 minutes at any one place, as in any given room for example. In special cases, as in supply and baggage rooms, the duration of the fire was longer; but the conditions of draught in such rooms were generally such that the fire smouldered and did not burn with as intense a heat. The average maximum temperatures attained in office and hotel buildings, as determined by the fusing of metals and other phenomena, ranged from 1500° to 1900° Fahrenheit. In certain spots, where there happened to be more than the average amount of fuel, and the conditions of draught were favorable, temperatures of about 2200° were sometimes reached. These maximum temperatures were not probably maintained for more than a few minutes in each case.

The Telephone Company's Main and South offices, the Merchants' Exchange, the Spreckels, Aronson, and Crocker buildings, and the Hotels St. Francis, Hamilton, and Alexander were subjected to the severest fires in buildings of this type.

In the store and loft buildings which, in addition to the combustible finish and furniture, frequently contained large quantities of inflammable stock or supplies, fires of much longer duration occurred. The actual

temperatures were seldom higher than those attained in the hotel and office buildings, but the length of time that the temperatures were maintained was much greater and in direct proportion with the amount and combustible qualities of the fuel. The Kamm Building was subjected to a more severe fire test than any other of the fire-proof buildings. The Sloane, Parrott, Scott, Johnson & Co., and Bullock & Jones buildings also contained evidences of intense and long-continued heat. In a few places, temperatures of about 2300° Fahr. were reached, but probably only for very limited periods.

The Fire-proofing Materials.

The materials used for floor construction in the fire-proof buildings were the burnt clay products and Portland cement concrete. The former have been used for fire-proofing purposes for thirty years or more, while the latter has been employed extensively only during the past ten years. An opportunity to compare these materials under approximately the same conditions occurred in the Baltimore fire, but in that conflagration it so happened that all the taller buildings were fire-proofed with hollow tile blocks, and the concrete construction was employed only in the smaller and lower bank buildings. In the San Francisco conflagration both materials were used in the tall buildings and under identical conditions, concrete having been employed in the great majority of cases.

From the detailed descriptions of the condition of the two materials after being subjected to fire, it is apparent that the hollow tile blocks sustained much greater injury, under the same conditions, than the concrete.

Hollow Tile.

In all cases where hollow tile was used for flooring, and where the blocks were not protected by a wire lath and plaster ceiling underneath, they were more or less damaged, the injury ranging from the falling away of the soffit shells, exposing the cellular spaces of a few blocks, to extensive areas comprising in some cases 90 per cent. of entire floors. In numerous places the blocks failed completely and fell away from the beams. Wherever extensive damage of this character occurred, the floors remained in a very weak and unsafe condition, necessitating the exclusion of all persons who wished to examine the buildings.

The brittle character of the material also renders it particularly undesirable, on account of its inability to resist the impact of heavy objects, such as safes, vaults, etc. In every building where the hollow tile floor arches were exposed to the flames, and which contained large safes, there are numerous cases of failure where the safes have broken through and destroyed the arches in successive floors below them to the basement.

Wherever a fire of normal intensity and of one-half hour's duration occurred the soffits of the tile blocks invariably failed. The tile slab soffit protection that is usually held in position by the dovetailed projections of the skewbacks also failed quite generally, falling away and exposing the soffits of the beams and girders. In a few places where small libraries or quantities of other inflammable materials produced fires of more than an hour's duration, the steel girders and beams, with the soffits exposed by the failure of the hollow tile protection,

were permanently deflected and will require straightening or re-rolling. In such cases, and generally where temperatures in excess of 2000° Fahr. were reached, the hollow tile was greatly injured by incineration, the material becoming inert and soft so that it could be crushed by the fingers.

Whenever the steel work became slightly distorted, as when columns buckled and settled, the hollow tile arches frequently fell out, their impact breaking down other tile arches below them that were not subjected to the same abnormal conditions.

There was no apparent difference in the fire-resisting qualities of the side or end construction methods, of the porous or hard-burned materials, or whether flat or segmental in form, but the blocks with heavier shells and webs generally developed better fire resistance than the lighter material. The best quality of hollow tile that was observed in the burned district was that used in the Chronicle Building Annex, which consisted of end construction terra cotta blocks, 16″ in depth and with shells and webs $\frac{7}{8}$″ in thickness. Even in the case of this material, an insignificant fire, resulting from the burning of scaffolding and a comparatively small quantity of wood trim, caused a number of the soffits to drop away, necessitating considerable repairs.

The damage to the soffit members of the hollow tile blocks is no doubt caused by the expansion due to unequal heating. The under side, which is exposed to the direct action of the flames, becomes very much hotter than the other portions of the block which are separated by air spaces of considerable size. There is consequently an immediate tendency of the under surface to expand and buckle downward, particularly in the case of first-class work, and where the mortar joints are solidly filled with mortar at the under side. It is probable that if the mortar joints could be kept open for an inch or so from the under surface, there would be less damage to the soffits in case of fire.

All this damage was caused by the fire only, and without the application of water. In every fire occurring in large cities with a well equipped fire department, water is invariably thrown into the burning buildings while the materials of construction are generally in a highly heated condition. It is well known that the sudden cooling of this material by water when heated to a high temperature is very destructive, and always causes vastly more damage than fire alone.

Common Brick.

In a few of the less important buildings, such as the stock houses of breweries, common rowlock, segmental brick arches were used. This is an excellent method for strength, and the fire resistance of common brick is well established. It is, however, a heavy construction, and it is difficult to adapt an efficient protection for the soffits of the beams and girders. Consequently where this method was employed, the soffits of the girders and beams were generally exposed.

In many of the recently published reports of the fire, the concrete floors are all referred to indiscriminately as "reinforced concrete." In order to make intelligent comparisons and arrive at correct conclusions, it is

Concrete.

necessary to distinguish the different materials as well as the principles involved. The concrete floors, with reference to their fire-resisting qualities, were of three general classes: (1) Segmental arches; (2) Short span flat slabs, and (3) Reinforced concrete construction.

In the segmental arches the entire cross section of the concrete is in compression, and the strength is entirely independent of light metal tensile elements which invariably weaken in a severe fire test. This type of flooring, with well designed concrete soffit protection, developed the best fire resistance. It was used in the Hotel St. Francis and withstood the earthquake and fire without damage to a single square foot of the large floor area.

The short span flat slab floors, next to the segmental arches, gave the best results. In this form of construction, the slabs are either very thick and without metal elements as in the lower stories of the Spreckels Building, or are about 4″ thick with metal elements incorporated in the concrete. In the best examples of the latter type, the sectional shape of the metal and its position in the slab was largely influenced by a consideration of fire resistance as well as strength. Consequently none of the usual formulæ for reinforced concrete will apply to these methods. When installed in connection with conventional steel designs in which the floor beams were spaced from 5 ft. to 7 ft. centres, this type of floor gave satisfactory results. Normal fires caused no apparent injury either to the concrete or to the metal lath and cement plaster soffit protection. Even under severe conditions, where fires of two to three hours' duration occurred, the soffit protection remained in position and fulfilled its purpose by preventing the permanent deflection of the steel members. The concrete floor slabs, under the same conditions, remained practically uninjured; a thin layer of the material, varying in thickness from $\frac{1}{8}$″ to $\frac{1}{4}$″ on the under side, being affected. This amount of the sectional area has no appreciable effect on the strength or efficiency of the slabs.

In the Telephone Co.'s main office building on Bush Street, portions of which were subjected to a particularly severe fire test of at least two hours' duration, a few of the concrete floor arches of the flat slab type deflected slightly under heavy loads during the fire. These were subsequently tested by uniformly distributed loads of 600 lbs. to the square foot; the loads being of sand in boxes without bottoms. The deflection under this load, of about $\frac{1}{32}$″, is almost identical with deflections under the same load imposed on similar constructions that have not been subjected to fire. This would indicate that the concrete arches retain substantially the same strength as before the fire, and are practically uninjured.

In the case of unusually severe conditions, as in the Kamm Building, where fires undoubtedly burned for many days, and where the fire-proof floors were subjected to the most severe test in the burned district, the concrete floors were not seriously damaged by the heat. Sections of the first floor, immediately above the basement story, where the intense and long-continued fire occurred, were apparently in good condition, only a

thin layer of $\frac{1}{2}''$ to $\frac{3}{4}''$ on the under side of the floor slab being affected by the fire. Had there been no column failures (which caused the wreck of the rear portion of this building), it is probable that the concrete floors throughout would have remained serviceable, and would not have required renewal.

The concrete floors, of both the segmental arch and short span flat slab type, were in all cases sufficiently strong, both at the time of the earthquake and during the fire, to sustain safes and other heavy bodies. No cases were observed where safes had broken through any of these floors.

Light reinforcing material, such as wire netting, expanded metal, etc., especially when exposed on the under side of the concrete slab, did not show as good results as steel bars of considerable sectional area.

In several cases, concrete of poor quality was originally installed in the work. This fact was determined by an examination of the concrete where it had been subjected to very little or no fire. Even in these cases, when subjected to normal fires, the concrete retains practically all of its original strength.

Both stone and cinder concrete were used in the segmental arch and short span flat slab types of fire-proof floors. There was no appreciable difference in the relative fire resistance of the two classes of concrete. It is, however, well known that cinder concrete at high temperature does not disintegrate under the action of a fire stream to the same extent as stone concrete and, for this reason, it is a superior material for fire-proof construction. Stone was used exclusively for the aggregates in reinforced concrete work.

The San Francisco Building Code, prior to the fire, did not legalize the construction of entire buildings of reinforced concrete. One building with reinforced concrete columns, girders, beams and floors, and brick walls was in the course of construction. There were, however, a number of buildings that contained reinforced concrete floors consisting of a floor slab, $4''$ to $9''$ in thickness, supported by reinforced concrete beams between steel girders. The principal distinguishing feature of reinforced concrete as compared with the preceding methods is the principle of using light steel rods or bars exclusively in tension and in accordance with rational formulæ. The spans between supports are also generally much greater.

Wherever reinforced concrete floors of this character were subjected to normal fires, such as occurred in office buildings or hotels, the deflection of the reinforced beams was always much greater than that of steel beams of the same carrying capacity.

An interesting demonstration of this fact occurred in the top story of the Telephone Co.'s main office on Bush Street, where reinforced concrete beams alternated with steel beams at about 7 ft. centers, carrying the same loads and being exposed to the same conditions. This story sustained a severe fire test, a large quantity of combustible supplies being stored in that part of the building in packing cases. The heat generated by this fuel caused the reinforced concrete beams to deflect badly, and one of them to fail. The alternate steel beams, with

a soffit protection equal to that under the metal of the reinforced concrete beams and consisting of crimped wire lath and cement plaster 1″ in thickness, were unaffected and were not permanently deflected.

Injuries and deflections to the reinforced concrete beams caused by fire were also noted in the Monadnock and Marston Buildings.

In Johnson & Co.'s Building, where a fire of greater intensity and duration occurred, the failure of the reinforced concrete beams was quite general, and no doubt contributed largely to the collapse of the sections of the building that were wrecked.

Reinforced concrete floors of long span suffered similarly, as was shown in the Bekins Van and Storage Co.'s building and the Annex of the Academy of Science, where insignificant fires exposed the reinforcing bars and caused deflections.

In reinforced concrete floor construction the strength is almost wholly dependent upon the light steel tension rods or bars, which economy requires to be imbedded at or near the under surface. In the case of a fire the light metal in this exposed position soon becomes heated, and by expansion and deflection disrupts the thin concrete covering under it. After the steel tensile members are exposed, temperatures of 1200° F. soon cause failures. Unequal heating while in a high state of stress and strain undoubtedly induced powerful tendencies toward rupture, and may also be a partial explanation of the unsatisfactory behavior of this construction when subjected to normal fires.

There were a sufficient number of instances of total and partial failures, and enough diversity in the size and manner of employing the reinforcing material, to fully warrant the conclusion that reinforced concrete, when used for floor construction, possesses relatively much less fire resistance than either the segmental arch or the short span flat slab types. Its use should therefore be limited to locations subject to moderate heat only.

Partitions.

The materials used for the construction of partitions were generally hollow tile blocks and metal lath and plaster. Neither of these materials gave entirely satisfactory results. The hollow tile partitions were sometimes overthrown by the earthquake and invariably failed to a greater or less degree in the fire. The light steel studs of the metal lath and plaster partitions expanded sufficiently to bulge or deflect the partitions out of plumb in many cases. These partitions, however, remained standing in nearly all cases and served a useful purpose as a fire barrier, and to prevent draughts. The hollow tile partitions, on the other hand, frequently caused the wreck of stairways and damage to the mechanical equipment by falling through the elevator shafts to the basement. On account of causing such damage, hollow tile blocks should not be used to enclose elevator and stairway openings, and when so employed they should be reinforced by vertical metal studs, anchored top and bottom, to prevent possible damage of this character.

A bad practice that was frequently followed was the erection of the hollow tile partitions from the top of

the fire-proof floors solidly to the under side of the fire-proof floors above, sometimes passing through metal lath and plaster ceilings. The advantage of building the partitions only to the wire lath ceilings, which act as a cushion and allow the partition to expand, was conclusively shown in the cases of the Flood and the Grant buildings.

A few partitions of reinforced concrete were found in several of the fire-proof buildings, but scarcely in sufficient quantities to warrant comparisons and final conclusions. In every case they developed good fire resistance, and remained in much better condition after normal fires of one-half hour to one hour duration than either of the two preceding types. The behavior of the reinforced concrete partitions was entirely satisfactory, and it is probable that partitions of this type 4″ to 6″ in thickness will fulfill all ordinary requirements in fire-proof buildings.

Column Protection.

One of the great lessons of the conflagration is the necessity of better protection for the steel columns. This is perhaps the most important new development of the conflagration. All the ordinary and accepted methods of column protection were shown to be insufficient under the severest conditions. One reason for this is the fact that in San Francisco, buildings designed for offices, lofts, light manufacturing purposes, etc., were frequently used as storage buildings for large quantities of inflammable goods. The combustion of these materials caused fires of greater intensity and much longer duration than any that occurred in the Baltimore buildings. In the Baltimore conflagration, buildings that were actually used as offices were practically the only type that were tested. Similarly, the recent Rochester fire attacked mainly buildings of the office type. The San Francisco fire was therefore the only one which produced conditions sufficiently severe to point out the defects and insufficiency of the usual practice.

Various methods and materials for column protection were employed; hollow tile blocks, 2″, 3″ and 4″ in thickness, were most generally used. Wire lath and plaster were also extensively employed. In the basements and cellars, the columns were usually covered by common brick. Concrete was also used to a limited extent. Of all these materials, concrete, when properly anchored to the columns, gave the best results. Common brick afford equally good protection, but unless anchored every 12″ to the columns, do not cling to them as satisfactorily as concrete. A double layer of metal lath and plaster, next to concrete and brick, developed the best fire resistance. In all cases where the double thickness was provided, the inner layer was unaffected and the structural members were satisfactorily protected. Where only one layer of wire lath and plaster was employed, and it was supported by well executed steel furring and anchored to the columns, it fulfilled the requirements under normal conditions that prevailed in offices, hotels and similar buildings. This method was not however, sufficient for the more severe requirements and failed in locations where fires of long duration occurred.

W. P. FULLER BUILDING. Mission and Beale Streets. This was a Class B building. The walls were of brick with wood floors supported by steel framing. The only part of the building fire-proofed was the columns. These were covered with stone concrete, anchored with No. 10 gauge steel wire wrapped spirally around the column at 16″ centres. This building was filled with a stock of paints, oils, etc., producing a hot, spectacular fire, and causing the total wreck of the structure. Note the tenacity of the concrete column protection, which remains in place after the severe fire test and the jarring sustained by the columns in falling over. The granite bases are badly spalled, this material being unsuited for carrying loads in locations where it is exposed to fire.

The hollow tile blocks which were most generally used varied considerably in efficiency. Where the blocks were erected in a careful and first-class manner, with good cement mortar and anchored to each other with metal ties at the corners, they sometimes fulfilled the requirements under normal conditions, but were frequently damaged and fell away from the columns. Where the blocks were erected in an indifferent manner the failures were very extensive and resulted in large damage. In numerous instances the bulging of pipes within the column covering facilitated the failures; the hollow tile blocks sustaining more damage from this cause than the other methods.

Superior results were always obtained when the column protection was erected independently of the partitions. When one side of the column protection was a partition surface and the other three sides were simply built around the column, the failure of the partition invariably exposed the column.

Metal Lath and Plaster Ceilings.

Wire lath and plaster ceilings, when erected in a first-class manner, with steel clips of sufficient size and strength, and when the lath was applied with a mild steel galvanized wire of about No. 18 B. & S. gauge, made an excellent showing. They, in all cases, developed better fire resistance than the soffits of the hollow tile floor blocks, and when used as suspended ceilings under inclined roof surfaces they invariably gave better results than the 3″ hollow tile blocks that were also used for this purpose. In many cases the wire lath and plaster ceilings were the only protection provided for beams and girders. Under normal conditions, and even in cases where fires of more than two hours' duration occurred, well constructed ceilings remained intact and seldom failed. Where the ceilings actually failed, the supporting clips were of light wire or of poor design; or a metal lath without stiffening ribs was employed. Solid rod stiffening ribs, on account of their considerable mass, add greatly to the life of metal lath in a fire. In a few buildings copper wire was used for securing the metal lath to the ceiling furring supports. The low temperature at which copper wire fuses makes it undesirable for this purpose, and was the cause of numerous failures. Steel lacing wire, which retains greater strength in high temperatures, is preferable and proved much more efficient. Wire for this purpose should in all cases be galvanized to prevent initial oxidation while the plaster is moist.

The good behavior of well executed ceilings of this character, warrants their continued use. In buildings of the office and hotel types, such ceilings afford sufficient protection for the soffits of the floor beams.

Safes and Small Vaults.

Portable safes and small vaults gave very unsatisfactory results. In many of the large office buildings, particularly those of Class B construction with wood floors, fires of sufficient intensity occurred to incinerate the contents of the largest safes. Many of these were of standard makes and supposed to be sufficiently fire-resisting to preserve their contents, the walls being in many cases 8″ to 12″ thick and filled with composition non-heat-conducting materials. One of these large safes, in the

VAULT of the Bancroft-Whitney Publishing Company. In the rear of a building on California Street between Kearny and Dupont Streets. A Standard Underwriters' metal covered door separated this vault from the basement of the building. The fire destroyed the door, igniting the contents of the vault, causing the total and partial failure of the cast-iron columns, and the failure of a section of the concrete arches supported by them. A double fire-proof barrier in the door opening of this vault would probably have saved the contents.

Crossley Building, became heated to such a degree that not only were the paper contents reduced to black ashes, but silver coins were partially fused, entire packages or rolls of 20 silver dollars being fused together into one piece.

In many of the fire-proof office buildings, where fires of much less intensity and shorter duration occurred, a majority of the better makes of safes preserved their contents in a fairly satisfactory manner. In most of these, however, the papers were scorched and discolored, and in some cases destroyed. There were very few instances where paper documents were preserved without injury.

The small steel vaults that were protected by hollow tile blocks or wire lath and plaster also failed in the majority of cases in the fire-proof buildings. When subjected to more severe fires than occurred in these buildings, the contents were always destroyed. Large vaults, with brick walls 13″ or more in thickness, were more successful, and when equipped with double steel doors, in all cases preserved the contents in good condition. Several special vaults, with reinforced concrete walls 4″ in thickness and double steel doors, also preserved their contents. It is therefore safe to conclude that a well constructed vault offers much more security for valuable documents, money, etc., than the best makes of portable iron or steel safes. For office building requirements such vaults should be built of reinforced concrete not less than 4″ or 6″ thick, or of common brick not less than 8″ thick, and equipped with double steel doors with an air space between them.

Portable iron safes must be considerably improved in their fire-resisting qualities before they can be depended upon to preserve their contents in a conflagration such as is likely to result in the combustion of the contents of ordinary office buildings.

Metal and Metal-covered Trim.

Metal and metal-covered wood trim and finish is a decided advantage in fire-proof buildings. The only building in which it was extensively employed was in the Kohl (or Hayward) Building. There was ample evidence in this building to show that the trim and finish resisted and retarded the spread of the fire, frequently confining it in the same room containing the windows through which the flames got access to the building. Without doubt, the entire interior of the Kohl Building, had it not been equipped with the metal-covered trim and finish, would have been fire swept in the same manner as was the Mutual Savings Bank.

Incombustible Floor Finish.

Cement, granolithic, mosaic, and other incombustible floor finish is a most desirable feature in buildings designed to be thoroughly fire-proof. The wood finish and trim comprise a considerable portion of the combustible contents of fire-proof buildings when the wearing surfaces of the floors are of wood. Even if the other finish and trim is of wood, an incombustible floor finish separates the wood surfaces so that fires of great intensity can rarely occur. In many of the recent fire-proof buildings incombustible floor finish has been employed with entirely satisfactory results and without any drawbacks or disadvantages.

Metal furring and lathing for ornamental effects is fairly satisfactory and usually fulfills the requirements. Well executed work of this character in all cases remains in place, and was uninjured even where considerable damage occurred to the plaster surfaces. It would not seem necessary to add to the expense or efficiency of this work, which fulfills its purpose as long as the plaster work remains intact.

Ornamental Furring and Lathing.

Wood roofs over fire-proof buildings are most undesirable. In several instances such roofs caused great damage, and after their destruction exposed the entire building to the elements. In the Chronicle Building the burning of a wood roof, together with the contents of the top story, without doubt started the precipitation of 19 linotype machines which fell through the hollow tile floors and wrecked the interior of the entire west side of the building. Wood roofs over fire-proof brewery buildings and over the Sub-Stations of the San Francisco Gas & Electric Co. largely increased the damage to these structures.

Wood Roofs.

Under the new building code, theatre construction in San Francisco will be much improved. It was a serious mistake to permit wood construction in large amusement buildings of this character. The ruins of the Tivoli Opera House are an object lesson even to the uninitiated in building construction.

Theatre Construction.

The resort to dynamite in the effort to check the spread of the flames is a questionable action. In the Baltimore conflagration similar attempts were made to check the fire, but without success. Great damage invariably resulted to adjoining buildings, and the disintegration of the buildings dynamited, when there was not sufficient time to remove the combustible parts of the *débris*, served only to make the conditions even more favorable for ignition and the rapid spread of the flames. In San Francisco there seems to have been a lack of good judgment in selecting the buildings to be dynamited, for in three cases fire-proof buildings of excellent construction were selected, and two of these were completely wrecked. In the case of the other building, a small section only was seriously injured, but considerable damage was caused to the parts in close proximity to the explosion.

Dynamiting.

The buildings of fire-proof construction generally serve as barriers to the rapid progress of the flames, and their destruction by dynamite was certainly a great mistake.

It is unfortunate that in the large number of fire-proof buildings tested by the recent conflagration, there were so few that had the window openings protected with fire-resisting barriers. In the few cases where the openings were protected, the methods varied, and in every instance but one they were incomplete. There are consequently little available data for comparing efficiencies, but in every instance the advantage of such protection to the buildings is clearly shown.

Protection of Window Openings.

The Telephone Co.'s main office on Bush Street was equipped with excellent protection of this character. The front windows were fitted with Kinnear outside corrugated steel rolling shutters, the glazing behind the shutters being of plate glass. The window openings on the other sides of the building were fitted with gravity, sliding, metal covered, inside shutters of good design. The outside glazing was wire glass with metal-covered sash and frames. For some unexplained reason, the rear door at the southwest corner of the building was left unprotected, and proved to be the vulnerable point. As described elsewhere, fire entered through this opening and destroyed the entire contents of the building.

By far the greatest damage to the window protection was caused by high temperatures within the building. The rolling shutters were little damaged, but the metal-covered shutters were seriously injured in many places, and some of the glazing was fused.

The Telephone Co.'s South Office on West Mission Street had the window openings of the two lower stories protected by wire glass in metal-covered frames, without shutters. This protection was sufficient to preserve the contents of these two stories, although the building was unoccupied at the time that the surrounding buildings were consumed. The third story, with unprotected openings, was fire-swept, and the expensive equipment, supplies, etc., were consumed.

The United States Mint was equipped in the two lower stories with inside folding iron shutters, which were of material assistance in protecting this building against ignition.

The most remarkable illustration of the advantage and efficiency of window protection was shown in the case of the California Electrical Company's building, at the northwest corner of Folsom and Hawthorne Streets. This was a non-fire-proof building with brick walls and wood floors. Although all the buildings around it were completely destroyed, this building and its contents were preserved in their entirety by metal sash and frames with wire glazing.

Reinforced Concrete.

Enthusiastic persons in favor of concrete construction, and interested contractors, have recently published and disseminated much reading matter advocating buildings constructed entirely of reinforced concrete as a type well adapted to resist earthquake shocks. Much of the information and many of the statements so published are misleading. It would therefore seem appropriate and necessary to sound a note of warning and conservatism to those who contemplate the erection of buildings of this class in sections subject to earthquake disturbances.

In typical reinforced or armored concrete buildings, not only the walls and the floors, but also the columns, girders and beams are built of stone concrete reinforced with steel rods, bars, etc. The radical feature of doubtful expediency in these buildings is the substitution of reinforced concrete for the steel columns, girders and beams which are ordinarily used in the best practice in fire-proof buildings.

It is well known that the standard connections in a well executed structural steel design will bear a considerable amount of distortion before being damaged or weakened to any serious degree. It is also a fact that in nearly every building, excepting only those founded on solid rock, there are more or less settlements in the foundations. Steel columns frequently settle several inches without serious consequences. In the case of a wall column the connections of the girders and beams are slightly distorted; a few cracks appear in the walls, and some of the wall material is crushed at the intersection of the wall girders and the column; but such displacements never appreciably weaken or endanger the structure. Even under the most severe and abnormal conditions, such as frequently occurred in the fire-proof buildings of the burned district, where interior columns settled from 2 feet to 6 feet, the badly distorted steel connections still held together and prevented the collapse of the steel frame and the total wreck of the buildings.

In reinforced concrete construction, however, slight displacements or settlements are of vital importance and a menace to the safety and integrity of the building. The light rods and bars which are ordinarily employed for reinforcing, and which are anchored in the concrete or simply hooked together, lack the positive rigidity, strength and tenacity of the standard steel connections, and would in no case withstand the same distortion without failure.

It was also conclusively shown in a number of instances in the recent conflagration that reinforced concrete girders and beams under identical conditions possessed much less fire resistance than steel members of the same carrying capacity.

Reinforced concrete columns and girders are much more bulky than similar members of equal capacity in steel. In order to adapt concrete buildings to withstand earthquakes, it would be necessary to provide an elaborate system of ties and braces, which would not only involve original and untested designs, but would also obstruct the head-room with unsightly structural members.

The success and safety of reinforced concrete depends wholly upon the uniformly good quality of the cement. A single barrel of damaged or poor quality cement going into the concrete of a column or a girder would create a weak spot and might at any time cause a fatal and expensive accident. Even under the most favorable conditions concrete girders and beams vary from 10 to 50 per cent. in actual strength when tested to destruction. This fact shows that it is not a uniform or homogeneous material like steel, and consequently it is less reliable.

In view of the foregoing considerations, reinforced concrete is not as well adapted as steel for columns, girders and beams, and should not be used for this purpose where steel is available.

The steel skeleton frame, consisting of columns, girders, and beams, has thoroughly demonstrated its ability to successfully resist earthquake movements, and absolute dependence can be placed on it to retain its strength

and integrity when subjected to the crucial test. It should be adopted in all cases for the better class of buildings, and particularly for hotels, offices, schools, institutions, and similar buildings that are to be occupied by large numbers of human beings.

Reinforced concrete has a useful and definite field in fire-proof building construction. The facility with which reinforced concrete can be anchored to the steel members renders it particularly well adapted for curtain wall construction in steel skeleton frame buildings. Concrete also possesses better fire resistance than any of the ornamental stones, such as granite, sand stone, etc. Being a monolith, it can be built much thinner than materials consisting of assembled pieces, which would make it more economical. The complex stresses and strains that obtain in horizontal beam and slab construction, and the tendency of the dead load to deflect and warp, are wholly eliminated in vertical wall construction. The reinforcing metal can also generally be located in the mid-section, where it is much less exposed to fire.

Reinforced concrete is therefore an excellent and economical material for curtain walls and partitions, and will undoubtedly be used extensively for this purpose in the steel skeleton frame buildings of the future. Whether or not it is capable of being executed in a sufficiently ornamental manner for the façades of the best buildings is a question which the skill of the workmen and actual practice must decide.

THE LESSONS OF THE DISASTER

In the preceding pages an effort has been made: (1) to point out those methods and details of building construction which developed good efficiency in the fire and the earthquake; (2) to call attention to those features of construction which were either defective or failed to fulfil the requirements; and (3) to note important omissions in the designs.

By adopting the good, discarding the bad and supplying the omissions, there should, in the future, be no difficulty in planning and erecting buildings that will be actually fire proof.

The best modern practice in the design of the foundations, the exterior walls and the steel skeleton structure is entirely satisfactory. A few details can be improved, but generally these features of the tall buildings fulfilled the requirements. The problem of making these structures fire-proof has, by the recent conflagration, been narrowed down to two principal features or details in the construction; the protection of the openings in the exterior walls, and the column protection in buildings which are to become the receptacles of large quantities of combustible contents.

The glaring omission of the fire-proof barriers for the exterior openings was the direct and sole cause of the damage and destruction to the interiors of nearly all the fire-proof buildings. This detail in the present stage of fire-proof construction is of paramount importance, and should receive special attention in all future buildings. It is manifestly idle to claim that any building is fire-proof so long as the window and door openings in the outside walls are unprotected by some efficient fire-resisting device.

The insufficiency of the usual practice in regard to column protection was shown in many instances, and is an important development of the recent conflagration. The definite and exact information on this subject that is now available should be of great value in the economical designing of future buildings.

To summarize and recapitulate, the lessons of the conflagration and the earthquake are given in the order of their importance, as follows:

THE LESSONS OF THE FIRE

I—Protect the Openings of the Outside Walls Against the "Exterior Fire Hazard"

This is the predominant and most important lesson of the fire. As in the case of the Baltimore fire and

other recent conflagrations, the flames were communicated to the fire-proof buildings from the outside through the windows and doors. Had suitable devices been provided in the window and door openings, the interiors of these buildings would have been wholly preserved, and the necessary repairs would have been limited to the restoration of the spalling and other damage to the exteriors.

There are now available practical devices to safeguard such openings. Metal, or metal-covered frames and sash, wire glass glazing and inside and outside metal shutters are to be had in great variety of design and finish. Similarly, metal and metal-covered door frames and doors are available to protect the door openings. The National Board of Fire Underwriters can furnish definite and detailed recommendations for specific cases.

An independent water supply, which can be provided by a tank on the premises, with suitable equipment, is also a desirable adjunct to protect the interiors of buildings.

II—Protect the Columns and Other Important Structural Members in Proportion to the Requiremen.

The results of this fire have shown conclusively that the ordinary and accepted methods of protecting columns are insufficient in the case of large stores, lofts, warehouses and similar buildings where large quantities of inflammable materials are to be stored. Concrete, well anchored with interior anchors attached to the columns at intervals of 12″ to 18″, showed the best results as a protecting material.

For office buildings, hotels, institutions and buildings of similar character, a protection 2″ thick of this material is sufficient. A double layer of wire lath and plaster, with an air space between, or 4″ hollow tile blocks laid in cement mortar, with the space between the blocks and the column filled solidly with concrete or mortar, will also fulfil the requirements. For stores, warehouses, depots and similar buildings, the thickness of the concrete protection should be increased to 4″. Common brick 4″ thick, laid in cement mortar with the space between the brick and the column filled solidly with concrete or cement mortar, will also provide suitable protection. For exceptionally severe requirements, the thickness of the concrete and the brickwork should be increased, respectively, to 6″ and 8″.

In all cases, whether the protection be of concrete, brick, hollow tile blocks or metal lath and plaster, it is most essential, in order to insure good efficiency, that it be securely anchored to the columns at not less than four points in the perimeter and every 12″ to 16″ of the length of the column. If such anchors are not provided, unequal heating, the expansion of the column and abnormal stresses and strains are liable to crack the protection and cause it to fall away, no matter how thick or excellent the protecting material may be.

Girders should be similarly and equally protected, concrete being the most efficient and readily adapt-

able material for this purpose. The beams, while less important members in the steel design, should nevertheless have a protection of approximately one-half that of the columns and the girders in each case.

Suitable protection should be provided for wall girders in cases where the soffits are near the heads of window openings. There were many instances where the wood frames were built directly against the under side of the wall girders, the deflection and bulging of which caused considerable damage to the walls. The neglect in certain cases to protect the steel framing around openings in the fire-proof floors also caused abnormal deflection and bulging to such an extent as to permit the floor spans adjoining the openings to fall out. The failure of large trusses supporting roofs, which frequently wrecked large portions of the interiors of buildings, was also caused by inadequate protection.

III—Use Refractory Materials for the Façades

Granite, marble, sand stone, limestone and similar building stones again proved unsatisfactory materials for exterior ornamentation when exposed to fire. All these stones scaled and spalled and were in many cases so badly damaged as to require entire renewal. These stones are also unsuited for bases, columns, lintels, caps, etc., to support loads in locations above ground where they may be exposed to fire.

Pressed Silica brick and terra cotta brick, made in the size of common brick, withstood the fire in San Francisco better than any other ornamental material. Pressed common brick also proved refractory and gave good results. Ordinary terra cotta, with thin shells and webs, while more refractory than the building stones mentioned, failed in numerous instances and gave satisfactory results only in cases where the material was made and erected with care and where the shells or walls were 2″ or more in thickness. This material when used should be provided with efficient anchors to hold it in position.

Common brick when laid in cement mortar also made an excellent showing, and can be depended on to form a complete and efficient barrier against fire. In all cases where face brick are used, at least every third or fourth course should be securely bonded to the backing.

IV—Select a Concrete Floor Construction of Recognized Strength and Fire Resistance

Concrete floors between steel beams, at 5 to 7 ft. centres, developed excellent and satisfactory fire resistance. They invariably sustained safes and heavy objects during the earthquake and the fire, and remained in position even in cases of the most abnormal distortion of the steel work.

Hollow tile, on account of its brittleness and lesser fire resistance, is not well adapted for fire-proof floor construction. Wherever this material was exposed to the flames in moderate and normal fires, such

as occurred in typical office buildings, it was more or less injured, the soffit surfaces falling away and exposing the cellular spaces. On account of its brittleness, safes frequently broke through it and fell from upper stories, crashing through successive floors to the basement, sometimes inflicting vast damage to the mechanical equipments.

V—Adopt Reinforced Concrete for Partitions

None of the usual methods of partition construction fulfils the requirements. Hollow tile blocks invariably failed in the fire, and by falling into stairway wells and elevator shafts, proved to be exceedingly destructive to the stairways and the mechanical equipments in the basements. Reinforced concrete is admirably adapted for partition construction, and in all the instances where it was used it gave entirely satisfactory results. Metal lath and plaster partitions, though liable to be distorted, can be depended upon to remain standing, and serve as a barrier to prevent draughts and the spread of the flames.

VI—Never Permit Pipes Inside of the Column Protection

The bulging of pipes from expansion, due to heating, damaged and disrupted the column protection in numerous instances before it would have failed otherwise. The location of piping in close proximity to columns is objectionable and exceedingly bad practice. Gases, moisture, etc., from such pipes are extremely injurious to the columns and facilitate oxidation. A separate inclosure, independent of the column protection, should in all cases be provided for vertical pipes.

VII—Provide Metal Treads for the Stairways

Marble and slate treads in stairways should be supported by metal underneath. In many cases where the treads of the stairways were simply outline framing supporting marble and slate slabs, the latter were destroyed or broken by the fire, and the stairways rendered unserviceable and dangerous. If metal treads are provided underneath the wearing surface, the stairways will remain serviceable during and after a fire, even in case the stone and slate slabs are damaged or destroyed.

VIII—Provide for the Expansion of Steel Lintels and Mullions

In numerous cases the expansion of steel lintels bulged the walls over the window heads, requiring extensive repairs. The vertical steel members for mullions frequently deflected and buckled when heated, dis-

rupting the masonry facing and causing it to fall away. When this occurred around interior light courts with a large skylight below, the *débris* from the mullions invariably broke the glass and damaged the frame of the skylight. By providing suitable spaces at the ends of lintels and expansion joints for the mullion members, this difficulty would be avoided.

IX—The Filling Between the Fire-Proof Floor Arches and the Under Side of the Finished Floor Should Never be Omitted

In several instances where this space was not filled, and the upper portion of the floor beams being left exposed, the burning of the wood floors and other combustible contents generated sufficient heat to warp and deflect the beams so as to require renewal, straightening or re-rolling. The filling of this space by a light incombustible material, such as cinder concrete, adds to the sound-proof qualities of the floors, and serves as a fire-resisting protection to the upper portions of the floor beams and girders.

X—Avoid Light Supports and Copper Wire in Metal Lath and Plaster Ceiling Construction

Many failures of the flat metal lath and plaster ceilings were caused by too light or poorly designed clips which supported the furring from the floor beams. Failures also occurred on account of the low fusing point of copper wire which was sometimes employed to attach the metal lath to the furring.

Supporting clips for furring should be made from not less than 1″ x ⅛″ steel stock and should hook around both sides of the lower flange of the beams. A mild steel galvanized lacing wire of not less than No. 18 B. & S. gauge should be used to attach the metal lath to the furring.

XI—The Small Steel Vaults and Portable Fire-Proof Safes, Even of Standard Makes, Proved most Ineffective in Preserving their Contents

A vault of suitable design and built of reinforced concrete or brick, as described in detail elsewhere, offers better security.

THE LESSONS OF THE EARTHQUAKE

XII—Avoid Locations in Close Proximity to Geological Fault Lines

XIII—The Foundation Must be Capable of Moving as a Unit

In order that the superstructure may withstand earthquake shocks, it is absolutely necessary that the

foundation be adequate and stable, and of sufficient strength to enable the entire base of the building to move as a unit.

XIV—Adopt the Steel Skeleton Frame Method for the Superstructure

Well designed and executed steel skeleton frame buildings withstood the earthquake without structural injury, and proved superior to all other methods. The superstructure should be securely anchored to the foundation, and be sufficiently rigid to move with it. The necessary rigidity or stiffness is secured by employing suitable bracing, which may consist of knee braces, gusset plates or deep girder connections. The mid-height of tall buildings should be particularly well braced on account of the racking tendency in that zone.

The columns should extend through two or more stories, and adjacent ones should never be spliced at the same level. Where the columns change in section or in size, great care should be exercised to avoid weakness at such connections. Open column sections should be given the preference.

Cast-iron columns and reinforced concrete columns, girders and beams should be used with caution and in comparatively low buildings only.

XV—The Best Materials and Workmanship Only are Admissible for Wall Construction

Practically all the damage to the mason work was due to the inferior mortar and poor bonding. With a good quality of mortar and first-class workmanship, similar damage will be largely avoided in the future. In the tall buildings curtain walls supported by the steel frame should be employed. In the construction of these walls, reinforced concrete, which can be readily anchored to the steel frame, is much to be preferred. In buildings of less height, with self-supporting or bearing walls of brick or stone, the walls should be well tied together, and cross or dividing walls should be provided at frequent intervals to stiffen and brace the structure.

XVI—Avoid High Chimneys and Towers of Plain Masonry

Steel chimneys with suitable linings fulfill all the requirements, and can be safely anchored and guyed in position. When necessary to construct high towers, a properly designed steel skeleton frame should be provided, in all cases.

XVII—Roofing Tiles should be Thoroughly Anchored in Position

In several instances, the roofing tiles were simply fastened with wires through a single lug near the centre of gravity at the under side. This method does not give satisfactory results. The tiles should have at least two lugs for supports. After being fastened in position "back-plastering" would increase the rigidity of the supports and add to their efficiency.

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